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ART. I.—WILLIAM S. SULLIVANT; *a Biographical Notice.* (From the Annual Report of the Council of the American Academy of Arts and Sciences, May, 1873.)

WILLIAM STARLING SULLIVANT died at his residence in Columbus, Ohio, on the 30th of April ult. In him we lose the most accomplished bryologist which this country has produced; and it can hardly be said that he leaves behind him any where a superior.

He was born, January 15th, 1803, at the little village of Franklinton, then a frontier settlement in the midst of primitive forest, near the site of the present city of Columbus. His father, a Virginian, and a man of marked character, was appointed by Government to survey the lands of that district of the "North Western Territory" which became the central part of the now populous State of Ohio; and he early purchased a large tract of land, bordering on the Scioto River, near by, if not including, the locality which was afterward fixed upon for the State capital.

William, the eldest son, in his boyhood, if he endured some of the privations, yet enjoyed the advantages of this frontier life, in the way of physical training and early self-reliance. But he was sent to school in Kentucky; he received the rudiments of his classical education at the so-called Ohio University, at Athens, upon the opening of that seminary; and was afterward transferred to Yale College, where he was graduated in the year 1823. His plans for studying a profession were frustrated by the death of his father in that year. This required him to

occupy himself with the care of the family property, then mainly in lands, mills, etc., and demanding much and varied attention. He became surveyor and practical engineer, and indeed took an active part in business down to a recent period. Leisure is hardly to be had in a newly-settled country, and least of all by those who have possessions. Mr. Sullivant must have reached the age of nearly thirty years, and, having married early,* was established in his suburban residence, in a rich floral district, before his taste for natural history was at all developed. His brother Joseph, next in age, was already somewhat proficient in botany as well as in conchology and ornithology; and when in some way his own interest in the subject was at length excited, he took it up with characteristic determination to know well whatever he undertook to know at all. He collected and carefully studied the plants of the central part of Ohio, made neat sketches of the minuter parts of many of them, especially of the Grasses and Sedges, entered into communication with the leading botanists of the country, and in 1840 he published "A Catalogue of Plants, native or naturalized in the vicinity of Columbus, Ohio," (pp. 63,) to which he added a few pages of valuable notes. His only other direct publication in phænogamous botany is a short article upon three new plants which he had discovered in that district, contributed to the American Journal of Science and the Arts, in the year 1842. The observations which he continued to make were communicated to his correspondents and friends, the authors of the Flora of North America, then in progress. As soon as the flowering plants of his district had ceased to afford him novelty, he turned to the Mosses, in which he found abundant scientific occupation, of a kind well suited to his bent for patient and close observation, scrupulous accuracy, and nice discrimination. His first publication in his chosen department, the *Musci Alleghanienses*, was accompanied by the specimens themselves of Mosses and Hepaticæ collected in a botanical expedition through the Alleghany Mountains, from Maryland to Georgia, in the summer of 1843, (the writer of this notice being his companion.) The specimens were not only critically determined, but exquisitely prepared and mounted, and with letter-press of great perfection; the whole forming two quarto volumes, which well deserve the encomium bestowed by Pritzel in his Thesaurus.† It was not put on sale, but fifty copies were distributed with a free hand among bryologists and others who would appreciate it.‡

* His first wife, Jane Marshall, of Kentucky, was a niece of Chief Justice Marshall. She died a few years after marriage.

† "Huic splendidæ impressæ 292 specierum enumerationi accedit elegantissima speciminum omnium exsiccatorum collectio."

‡ A tribute is justly due to the memory of the second Mrs. (Eliza G. Wheeler) Sullivant, a lady of rare accomplishments, and, not least, a zealous and acute bryol-

In 1846, Mr. Sullivant communicated to the American Academy the first part, and in 1849, the second part of his "Contributions to the Bryology and Hepaticology of North America," which appeared, one in the third, the other in the fourth volume (new series) of the Academy's Memoirs,—each with five plates, from the author's own admirable drawings. These plates were engraved at his own expense, and were generously given to the Academy.

When the second edition of Gray's Manual of the Botany of the Northern United States was in preparation, Mr. Sullivant was asked to contribute to it a compendious account of the Musci and Hepaticæ of the region; which he did, in the space of about a hundred pages, generously adding, at his sole charge, eight copper-plates, crowded with illustrations of the details of the genera,—thus enhancing vastly the value of his friend's work, and laying a foundation for the general study of bryology in the United States, which then and thus began.

So excellent are these illustrations, both in plan and execution, that Schimper, then the leading bryologist of the Old World, and a most competent judge, since he has published hundreds of figures in his *Bryologia Europæa*, not only adopted the same plan in his Synopsis of the European Mosses, but also the very figures themselves (a few of which were, however, originally his own), whenever they would serve his purpose, as was the case with most of them. A separate edition was published of this portion of the Manual, under the title of "The Musci and Hepaticæ of the United States, east of the Mississippi River," (New York, 1856, imperial 8vo,) upon thick paper, and with proof-impressions directly from the copper-plates. This exquisite volume was placed on sale at far less than its cost, and copies are now of great rarity and value. It was with regret that the author of the Manual omitted this cryptogamic portion from the ensuing editions, and only with the understanding that a separate *Species Muscorum* or Manual for the Mosses of the whole United States should replace it. This most needful work Mr. Sullivant was just about to prepare for the press.

About the same time that Mr. Sullivant thus gave to American students a text-book for our Mosses, he provided an unequalled series of named specimens for illustrating them. The ample stores which he had collected or acquired, supplemented by those collected by M. Lesquereux (who was associated with him from the year 1848) in a journey through the mountainous parts of the Southern States under his auspices,

ogist, her husband's efficient associate in all his scientific work until her death, of cholera, in 1850 or 1851. Her botanical services are commemorated in *Hypnum Sullivantiæ* of Schimper, a new moss of Ohio.

after critical determination were divided into fifty sets, each of about 360 species or varieties, with printed tickets, title, index, etc., and all except a few copies for gratuitous distribution were generously made over, to be sold at less than cost, for his esteemed associate's benefit, and still more that of the botanists and institutions who could thus acquire them. The title of this classical work and collection is *Musci Boreali Americani quorum specimina exsiccata ediderunt W. S. Sullivant et L. Lesquereux;* 1856. Naturally enough, the edition was immediately taken up.

In 1865 it was followed by a new one, or rather a new work, of between five and six hundred numbers, many of them Californian species, the first fruits of Dr. Bolander's researches in that country. The sets of this unequalled collection were disposed of with the same unequalled liberality, and with the sole view of advancing the knowledge of his favorite science. This second edition being exhausted, he recently and in the same spirit aided his friend Mr. Austin, both in the study and in the publication of his extensive *Musci Appalachiani.*

To complete here the account of Mr. Sullivant's bryological labors illustrated by "exsiccati," we may mention his "*Musci Cubenses,*" named, and the new species described in 1861, from Charles Wright's earlier collections in Cuba, and distributed in sets by the collector. His researches upon later and more extensive collections by Mr. Wright remain in the form of notes and pencil sketches, in which many new species are indicated. The same may be said of an earlier, still unpublished collection, made by Fendler in Venezuela. Another collection, of great extent and interest, which was long ago elaborately prepared for publication, and illustrated by very many exquisite drawings, rests in his portfolios, through delays over which Mr. Sullivant had no control; viz., the Bryology of Rodgers' U. S. North Pacific Exploring Expedition, of which Charles Wright was botanist. Brief characters of the principal new species were, however, duly published in this as in other departments of the botany of that expedition. It is much to be regretted that the drawings which illustrate them have not yet been engraved and given to the scientific world.

This has fortunately been done in the case of the South Pacific Exploring Expedition, under Commodore Wilkes. For, although the volume containing the Mosses has not even yet been issued by Government, Mr. Sullivant's portion of it was published in a separate edition, in the year 1859. It forms a sumptuous imperial folio, the letter-press having been made up into large pages, and printed on paper which matches the plates, twenty-six in number.

One volume of the Pacific Railroad Reports, i. e., the fourth, contains a paper by Mr. Sullivant, being his account of the

Mosses collected in Whipple's Exploration. It consists of only a dozen pages of letter-press, but is illustrated by ten admirable plates of new species.

The *Icones Muscorum*, however, is Mr. Sullivant's crowning work. It consists, as the title indicates, of "Figures and Descriptions of most of those Mosses peculiar to Eastern North America which have not been heretofore figured," and forms an imperial octavo volume, with 129 copper-plates, published in 1864. The letter-press and the plates (upon which last alone several thousand dollars and immense pains were expended) are simply exquisite and wholly unrivalled; and the scientific character is acknowledged to be worthy of the setting. Within the last few years most of the time which Mr. Sullivant could devote to science has been given to the preparation of a second or supplementary volume of the *Icones*. The plates, it is understood, are completed, the descriptions in a good degree written out, and the vernal months in which his mortal life closed were to have been devoted to the printing. The Manual of North American Mosses was speedily to follow. He was remarkably young for his years, so that the hopes and expectations in which we were indulging seemed reasonable. But in January, not far from his seventieth birthday, he was prostrated by pneumonia, from the consequences of which, after some seeming convalescence, he died upon the last day of April. He leaves a wife, Mrs. Caroline E. (Sutton) Sullivant, children, grandchildren, and great-grandchildren, to inherit a stainless and honored name, and to cherish a noble memory.

In personal appearance and carriage, no less than in all the traits of an unselfish and well-balanced character, Mr. Sullivant was a fine specimen of a man. He had excellent business talents, and was an exemplary citizen; he had a refined and sure taste, and was an accomplished draughtsman. But after having illustrated his earlier productions with his own pencil, he found that valuable time was to be gained by employing a trained artist. He discovered in Mr. A. Schrader a hopeful draughtsman, and he educated him to the work, with what excellent results the plates of the *Icones* and of his other works abundantly show. As an investigator he worked deliberately, slowly indeed and not continuously, but perseveringly. Having chosen his particular department, he gave himself undeviatingly to its advancement. His works have laid such a broad and complete foundation for the study of bryology in this country, and are of such recognized importance everywhere, that they must always be of classical authority; in fact they are likely to remain for a long time unrivalled. Wherever Mosses are studied, his name will be honorably remembered; in this country it should long be remembered with peculiar gratitude.

In accordance with his wishes, his bryological books and his exceedingly rich and important collections and preparations of Mosses are to be consigned to the Gray Herbarium of Harvard University, with a view to their preservation and long-continued usefulness. The remainder of his botanical library, his choice microscopes, and other collections are bequeathed to the State Scientific and Agricultural College, just established at Columbus, and to the Starling Medical College, founded by his uncle, and of which he was himself the Senior Trustee.

Mr. Sullivant was chosen into the American Academy in the year 1845. He received the honorary degree of Doctor of Laws from Gambier College, in his native State. His oldest botanical associates long ago enjoyed the pleasure of bestowing the name of *Sullivantia Ohionis* upon a very rare and interesting, but modest and neat Saxifragaceous plant which he himself discovered in his native State, on the secluded banks of a tributary of the river which flows by the place where he was born, and where his remains now repose. A. GRAY.

ART. II.—*On some results of the Earth's Contraction from cooling;* by JAMES D. DANA. Part II, *The Condition of the Earth's Interior, and the connection of the facts with Mountain-making.* III, *Metamorphism.**

II. THE CONDITION OF THE EARTH'S INTERIOR.

THE condition of the earth's interior is not among the geological results of contraction from cooling. But these results offer an argument of great weight respecting the earth's interior condition, and make it desirable that the subject should be discussed in this connection. Moreover, the facts throw additional light on the preceding topic—the origin of mountains.

It seems now to be demonstrated by astronomical and physical arguments—arguments that are independent, it should be noted, of direct geological observation—that the interior of our globe is essentially solid. But the great oscillations of the earth's surface, which have seemed to demand for explanation a liquid interior, still remain facts, and present apparently a greater difficulty than ever to the geologist. Professor LeConte's views, in volume iv, were offered by him as a method of meeting this difficulty; yet, as he admits in his concluding remarks, the oscillations over the interior of a continent, and the fact of the greater movements on the borders of the larger ocean, were left by him unexplained. Yet these oscillations are

* For Part I, on the Origin of Mountains, see vol. v, p. 347.

not more real than the changes of level or greater oscillations which occurred along the sea border, where mountains were the final result; and this being a demonstrated truth, no less than the general solidity of the earth's interior, the question comes up, how are the two truths compatible?

The geological argument on the subject (the only one within our present purpose) has often been presented. But it derives new force and gives clearer revelations when the facts are viewed in the light of the principles that have been explained in the preceding part of this memoir.

The Appalachian subsidence in the Alleghany region of 35,000 to 40,000 feet, going on through all the Paleozoic era, was due, as has been shown, to an actual sinking of the earth's crust through lateral pressure, and not to local contraction in the strata themselves or the terranes underneath. But such a subsidence is not possible, unless seven miles—that is, seven miles in maximum depth and over a hundred in total breadth—unless seven miles of *something* were removed, in its progress, from the region beneath. If this *something* was only vapor or gas, then seven miles of open space must have existed there; and this could not have been, except through seven miles of local contraction along the region; but such an open space, if of possible formation, would have been obliterated by catastrophic subsidence, instead of the slow movement that actually took place. And, moreover, such open spaces, of no less extent, must have existed, in one or more ranges, underneath all continental borders. This is proved, and, at the same time, the extreme improbability of their existence demonstrated, by the facts reviewed beyond.

If the matter beneath was not aerial, then liquid or viscous rock was pushed aside. This being a fact, it would follow that there existed, underneath a crust of unascertained thickness, a sea or lake of mobile (viscous or plastic) rock, as large as the sinking region; and also that this great viscous sea continued in existence through the whole period of subsidence, or, in the case of the Alleghany region, through all Paleozoic time—an era estimated on a previous page to cover at least thirty-five millions of years, if time since the Silurian age began embraced fifty millions of years.

The under-Appalachian fire-sea, if a reality, must hence have had a long continuance.

But, on the above condition, it could not have begun its existence later than the period of disturbance closing pre-Silurian time. Earlier, great subsidences were involved in the deposition of the material of which the Blue Ridge, Highland Ridge, Adirondacks, and the Archæan heights farther north were made; and the under-crust sea would have been, through

all, a necessity. In fact, it is difficult to find a reason for doubting its having dated back to the era of general fluidity.

Directly following the Paleozoic, or as its closing event, as explained on a preceding page, occurred the plicating of the Alleghany rocks to their depths miles below, and the crystallization of part of them; and this epoch ended in the making of the mountains—a synclinorium—and the annexation of the central and western part of the region to the essentially stable area of the continent; and if motion in the rocks was ever transformed into heat, the under-Appalachian sea should have had its temperature, or its extent, or both, increased. Then, after the Appalachian region had thus become essentially stable, the locus of the region of yielding was moved to the eastward. The long range of the Triassico-Jurassic beds, on the Atlantic border from Nova Scotia to southern North Carolina, show the positions of the new troughs, as stated on page 437.* These subsidences, amounting to 4,000 feet in some parts, ended in a tilting of the beds and in fissure-eruptions through all these sandstone regions from the most northern to the most southern. Now the question arises, whether the great under-Appalachian fire-sea of the Paleozoic continued on through the Triassic and Jurassic periods of the Mesozoic, and thus favored the subsidences and eruptions that then took place; or, whether the old sea of viscous rock, after being increased in extent or temperature by the profound plicating and faulting of the Appalachian revolution, then ceased to exist—in some way difficult to understand—and others were made, farther east, by the later movements? Such a ceasing with a subsequent renewal is seemingly improbable; and if it did not occur, then the under-Appalachian fire-sea continued from the Paleozoic far into the Mesozoic era.

When the material of the under-Appalachian sea was pushed aside by the subsiding Paleozoic deposits of the Appalachian region, what became of it? Some of it may have moved off southward. The chief part would have passed either to the *west*, or to the *east*. That it did not go *west* is evident from the ascertained fact that the oscillations in that direction during Paleozoic time were small; for the region was then, the larger part of the time, a mediterranean salt-water basin or sea, nurturing crinoids, corals and mollusks, and making limestones. If not westward, then it passed *eastward:* and if driven eastward, a geanticlinal elevation of a sea-border region parallel with the area of subsidence must have been in progress from lateral pressure. The height of this geanticlinal, or swell of the overlying crust (anticlinorium), would have depended on the distance to which escape eastward was possible, that is, on the eastward extent of the subterranean region of mobile rock. Its elevation was

* Last volume of this Journal.

probably small and of varying extent during the Silurian and Devonian; for Devonian fossils show that the sea-border south of New York had some way an open connection with the Atlantic ocean; but there is no evidence in the Appalachian rocks of the Carboniferous era to prove that off New Jersey it was not, at that time, almost or quite a complete barrier; the marine fossils in the more eastern of the Pennsylvania Coal-measures are rare, and those in the western Pennsylvania beds would have been from the waters of the mediterranean sea over the Mississippi basin, which reached northward from Alabama, and, east of the Cincinnati uplift, bathed all the western part of the Appalachian region, and probably its whole breadth.

When, at the beginning of the making of the Alleghanies, the strata commenced to yield before the pressure and to become pushed up into great folds, the geanticlinal of the sea-border would have subsided in part, in consequence of the removal of resistance in front of it; and this tendency to subside by gravity may have been part of the means by which the plication was made to go forward, its action adding to that of the pressure. But the subsidence did not continue to the obliteration of the geanticlinal; for it was still above the ocean's level during the following era—the Triassico-Jurassic. The absence of all remains of distinctively marine fossils from these rocks, and from any rocks of the Triassic or Jurassic eras in view over the Atlantic border, demonstrate (as I have long held) that an emerged area then existed outside of the present coast line. Moreover, inasmuch as these Triassico-Jurassic areas (situated on the Atlantic slope parallel with the Appalachians) were subsiding while their rocks were in progress, the sea-border anticlinorium should, at the time, have taken another turn upward, as a counterpart to this subsidence.

With the close of the Triassico-Jurassic era, if not before, the great *anticlinorian* barrier began actually to disappear; and by the time the Cretaceous period opened it had so far sunk that the Atlantic coast region south of New York was again exposed to the ocean, and flourished with abundant marine life, the Cretaceous fossils of the coast giving full evidence on this point. Thus the absence from the present Atlantic border of all Triassic and Jurassic marine fossils and the presence of Cretaceous species in great numbers are well accounted for.

Prof. Hunt has recognized the existence, on the Atlantic border of the continent and outside of it, during the Paleozoic era and earlier, of an emerged region, and has appealed to various bare Archæan areas in New England and to the northeast, and to the Archæan character of the Blue Ridge, etc., as proof. He has designated the region, badly, as an "eastern continent," and finds in it, with reason, a source for much of the

sedimentary material that was used in making the Appalachian and other rocks. Prof. LeConte also brings into his views such an elevation, and remarks upon its final disappearance. But neither of these authors states that he regards it as part of a system of oscillations set in motion by the lateral pressure resulting from the earth's contraction, and a direct counterpart to the geosynclinal of the Appalachian region. Their views are adverse to such an idea, the subsidence with them being not due to contraction.

The facts thus sustain the statement that lateral pressure produced not only the subsidence of the Appalachian region through the Paleozoic, but also, cotemporaneously, and as its essential prerequisite, the rising of a sea-border elevation, or geanticlinal, parallel with it; and that both movements demanded the existence beneath of a great sea of mobile rock.

The movement and mountain-making over other parts of the Atlantic border (v, 436), and also the grand double series of events on the Pacific or Rocky Mountain border (v, 438), sustain and illustrate the same views. The under-crust fire-sea on the Pacific border must have had great length from northwest to southeast; and also great breadth, for the border region is at least 1,000 miles wide; and great breadth and great length seem plainly its characteristics even till Tertiary times. And did it continue on through the Tertiary and afford the floods of rock that were poured out from the deep fissures of this long era? And was it still in existence when the great floods were poured forth over the drift gravel beds?

It is further to be noted that, in the course of past time, the whole continent has had its surface from one side to the other criss-crossed with oscillations and lines of disturbance, from the lateral pressure acting against its opposite sides, whence it is clear that the continental subterranean seas were *once* continuous. An appeal to the other continents for further testimony is hardly necessary.

The facts from the ocean seem to demand a vastly greater range for the under-crust mobile layer. The coral island subsidence, during the Quaternary and part or all of the Tertiary, could hardly have been due simply to radial contraction from cooling; for this would make the cooling over the tropical part of the ocean in this small part of geological time sufficient to produce there a sixth of the oceanic depression. Is it not proof that even then the plastic layer had enough of extent beneath the tropical part of the oceanic crust to permit of such a sinking, under the irresistible lateral pressure at work? However this be, it stands as a fact to be explained.

In view of the conclusions here reached with regard to the earth's interior, I present the following statements:

1. That this restriction of the interior liquidity of the earth to an undercrust layer, does not require in itself any modification of the views I presented, more than twenty-five years since, on the results of the earth's contraction, since there is still a flexible crust and mobile rock beneath it.

2. The condition of the earth's interior here recognized is, as many readers will have observed, that suggested long ago by Professor W. Hopkins—the author who first offered a mathematical argument in favor of the earth's either having a very thick crust or being solid throughout.* In a paper on Theories of Elevation and Earthquakes, in 1847,† Prof. Hopkins argues that the central mass of the earth became solid in consequence of the pressure, whenever the temperature within reached a limit that permitted of it; that crusting at surface from cooling commenced afterward; and that between the regions of interior and exterior solidification, there long remained a viscous layer, which, in the progress of time, was gradually contracted by the union of the solid nucleus to the thickening shell.

3. The possibility of solidification at center from pressure, in the face of a temperature too high for consolidation from cooling, has not been experimentally demonstrated. Yet a number of facts favor the principle. It has been urged that since the solidification of rocks is attended by contraction, that is, by increase of density, and since pressure tends to produce this greater density, therefore pressure may bring about the condition of the solid. The fact that ice, which has less density than water, changes to water under pressure, has been appealed to in support of the conclusion. The pressure to which the material within the earth is subjected is so great that experiment can never imitate it, or directly test its effects. Beneath only one hundred and fifty miles of liquid rock it would be not less than one million of pounds to the square inch. Less than this may have been sufficient to produce crystallization, and so give rigidity to the viscous rock-material, or at least so, after the cooling the earth has undergone. The rigidity of slowly solidified rock is beyond that of glass or steel—or the degree which, according to Sir Wm. Thompson, must exist in order that the earth should be as completely free as it is from tidal movements in its mass.

* Trans. Roy. Soc., 1839.

† Rep. Brit. Assoc. for 1847, p. 33. The theory of elevation advocated in this paper attributes elevation, not to lateral pressure from contraction, but to evolved vapors underneath the elevated region. The array of facts which have been presented respecting the positions of mountain ranges, their relations to the great areas of depression, their successive formation on sea-borders in parallel ranges, and the natural evolution of the whole from the universal action of the one great cause, contraction, has appeared to me to afford the most complete demonstration that the vapor theory is not necessary, at least as regards mountain ranges. The fact also that mountains so raised could not hold themselves up, has seemed to be an insuperable difficulty to the success of the method.

4. According to the above, the solid part of the globe consists, as regards origin, of three parts.

a. The central mass, consolidated by pressure; the solidification *centrifugal*, or from the center outward.

b. The crust proper, consolidated by cooling; the solidification *centripetal*, or from the surface inward.

c. The outer crust, or superficial coatings—the supercrust—made chiefly by the working over and elaborating of the material of the surface through external agencies, aided by the ever-acting lateral force from contraction, and including all terranes from the Archæan upward.

5. As to the thickness of the viscous layer and the overlying crust, or the depth of the later under-crust seas, I have nothing to offer. The Appalachian subsidence might have been accomplished with but seven or eight miles of depth underneath.

The under-crust fire-seas would have had their heat from time to time supplemented through the movements of the crust. But the ordinary oscillations of the crust were so extremely slow and so ineffectual in producing heat, and the greater mountain-making movements occurred at so very long intervals—many millions of years—and then were so very limited in area compared with the earth's surface, that this cause could not have prevented a gradual narrowing of their limits with the progressing refrigeration. But even after the general union of the crust and nucleus, giving the earth *trap-like* "rigidity," had taken place, leaving only local fire-seas, the connection may not have been so complete that it would not have sometimes yielded enough to the slow working of lateral pressure, to have permitted oscillations of nearly continental extent, like those of the Post-tertiary.

A final word on Mountain-making. From the above we learn that, in the work of mountain-making in eastern North America, there was first the commencing and progressing geanticlinal on the sea-border; and, as a concomitant effect of the lateral pressure, a parallel geosynclinal farther west, along the border of the continent. Concurrently, the deepening trough of the geosynclinal was kept filled to the water level, or nearly, by sedimentary accumulations, until these had become seven miles in thickness; and, as a consequence, the lines of equal temperature (isogeotherms) in the crust beneath gradually rose upward seven miles; and further, the geosynclinal crust, owing to this rising of heat from below, lost part of its thickness by a melting off of an under portion, and also part of its strength up to a higher level by the softening action of the heat, while it received, as the only compensation for the loss of thickness, the addition of half-consolidated sediments above. Finally, the geosynclinal region, owing to its position against the more stable

continental mass beyond it, and to the weakness produced in its crust in the manner explained, became, under the continued lateral pressure and the gravity of the geanticlinal, a scene of catastrophe and mountain-making after the manner described.

The principle here brought in, that the weakening of the crust through the rise of the isogeotherms was one occasion of the catastrophe, is made of prominent importance by Professor LeConte (vol. iv, p. 468), though by a somewhat different method.

The geological facts thus far gathered have not yet proved that there was a geanticlinal on the Pacific border (like that of the Atlantic), as a counterpart to the geosynclinals in progress; but the evidence may be looked for with confidence.

III. Metamorphism.

The fact that all metamorphic or crystalline rocks are upturned or plicated rocks has led many to believe that disturbance and plications were essential features of an epoch of metamorphism; and that Herschel's theory, which attributes metamorphism to the heat that rises into the strata owing to accumulation above (a rise of the isogeotherms) is insufficient. This conclusion is certainly confirmed by finding no evidence of metamorphism in the lowest beds of the Carboniferous series of Nova Scotia, where, since the series has a thickness of nearly 16,000 feet, according to two of the best geologists in the world, Logan and Dawson, the bottom temperature must have been, when the series was completed, at least 330° F. It is still better sustained by the observation that the lower of the forty thousand feet of strata in the Appalachian region, were, where measured by the Professors Rogers, *not metamorphic*—the Chazy and Trenton limestones being ordinary uncrystalline limestones. And yet the temperature in these inferior beds, marked by the ascending isogeotherms, must have been before their disturbance, as calculated by Prof. LeConte, not less than 800° F., and much above this, if more heat escaped from the earth then than now. Thus seven miles of accumulations were not sufficient to bring about metamorphism or crystallization even in the lowest stratum, or any change beyond that of ordinary solidification.*

It seems certain, therefore, that this method of obtaining the heat, by blanketing the surface with strata, is not sufficient.

Neither, as Mallet has observed on page 303 of the last volume of this Journal, can heat be derived from simple pressure or "mechanical compression," as the language of Vose sug-

* The arguments here presented are the same that I urged in this Journal, in vol. xlii, p. 252, 1866.

gests.* But with *movements* in the strata, or progressive plications, such as the metamorphic rocks themselves show they have experienced, then, according to the principle of the transformation of motion into heat, first suggested with reference to metamorphism by Prof. Henry Wurtz, of New York, in 1866,† and recently applied to volcanoes and demonstrated by Robert Mallet, Esq., the conditions for metamorphism might be complete, even with comparatively little help from a rise in the isogeotherms. This result would certainly follow if the heat from motion is great enough, as Mallet appears to show, to produce fusion. Such a cause is capable, as others have urged, of producing the heat throughout the strata, just where it is needed for work. Under it, accumulations of strata of like thickness and composition would be differently acted upon according to the three conditions: (1) the amount of motion, one principal source of heat; (2) the thickness of the series of beds undergoing movement, another source of heat beneath; (3) the amount of moisture present in the beds. Thus widely diverse metamorphic rocks might be made of the same material; and if a region of feebly-metamorphic rocks is found to lie side by side with one of thoroughly-metamorphic, the strata of the two may have originally been similar, and of one and the same geological horizon.

Metamorphism over large areas is thus one of the direct results of the earth's contraction. Solidification is often only a lower stage in the same process; and the reddening of sandstones, as already explained,‡ is frequently involved with it.

* Vose could hardly have intended to say in place of pressure, the *motion* produced by pressure. For, in one of his paragraphs, he attributes the changes distinctly to "the enormous pressure generated in the folding of masses of rock, the depth of which is measured by miles"; and this pressure was that of gravitating sediments alone, while the additional heat required came from a rise in the isogeotherms in consequence of surface accumulations. The truth is that, instead of folding generating pressure, the pressure generated the folding; and the movement attending folding was essential to the existence of the heat requisite for metamorphic changes. Thus the views of Vose and Hunt are set aside by Mallet, instead of being, as Prof. Hunt says (the last volume of this Journal, p. 270), "confirmed by them." In a letter of May 10th to the writer, Mr. Mallet refers to his opposition to Herschel's theory, and adds that he was "rather amused" at finding himself brought forward by Prof. Hunt in support of it. Mr. Vose's views are contained in his work on Orographic Geology, published in Boston in 1866 (136 pp. 8vo).

† This Journal, v, 385. Prof. Wurtz's opinion was first published in a paper on "Gold genetic metamorphism," in the American Journal of Mining (New York), Jan. 25, 1868. The paper was read at the meeting of the American Association at Buffalo, in August, 1866.

‡ Page 430 of the preceding volume.

ART. III. — *Photography of Southern Star-clusters;* by C. S. SELLACK, at present Professor of Physics in the University of Cordoba, South America.

IN the beginning of last year, under an arrangement made with Mr. Rutherfurd in New York, and at the expense of some gentlemen from Boston, I went to Cordoba to take, in the Argentine National Observatory,* photographs of southern star-clusters, employing the methods of Mr. Rutherfurd. The method of Mr. Rutherfurd is the following. After an exposure of the photographic plate for some minutes, the telescope, which is driven by a good clockwork, is moved to another position by the slow motion, and a second exposure is made; then the telescope is stopped and an exposure made so that the image of the central star, while moving out of the field, leaves a trail. The images of the stars being double, the recognition and discrimination from specks produced by impurities of the plate is very much facilitated; the trail serves to fix a direction for the angles of position on the plate. When the trail could not be obtained for want of brightness of the central star, I made a third exposure some minutes distant from the first, by starting the telescope again after some minutes stopping.

The photographic refractor of about $0{\cdot}280^{m}$ aperture, formerly owned by Mr. Rutherfurd, now property of the Cordoba Observatory, was to be used for the work. On my arrival in Cordoba the lens, which for a long time had been kept packed up in Cordoba, was found broken; the flint-lens was divided in two by a crack near the middle. The object of my voyage seemed to be frustrated. The optical refractor of the same dimensions, which the observatory possesses, proved unfit for photographic purposes. In using only one half of the broken flint-lens the intensity of light would have been too much reduced for the intended work. If anything at all was to be accomplished, the two pieces of the broken lens had to be fitted together.

I undertook this task with the assistance of a watchmaker in Cordoba, constructing an adjusting apparatus. On the circumference of each of the two segments of the lens, at the corners of the break and in the middle, were put three little metal clasps; pairs of pulling and butting screws, inserted in small metal pieces fastened on to the frame of the lens, worked on these clasps, so that with them the pieces of the lens could be lifted and lowered. A slight motion of the pieces of the lens parallel to its surface could be effected by little wedges, the frame giving some play to the lens.

* Under the charge of Dr. B. A. Gould.

The adjustment of the lens was to be done by continued photographing of stars, as the image is not sharp for mean visible rays, and even observation through a blue glass did not show it distinctly enough. The lens had to be taken out of the telescope for each correction, which was done many a hundred times. The image of the star was photographed, not only in its true focus, but at different distances before it, so that the section of the converging light was obtained; the shape and arrangement of light in these sections allowed a better judgment of the state of the different parts of the lens. As the object was not the adjustment of parts of a simple lens, but of the diverging lens of a system, it is obvious that mistakes in correcting the screws were easily made. Displacement of the two pieces of the lens produces double images in the manner of the heliometer, except that in this case the concave lens alone makes the effect; tilting of the pieces about the edge of the crack has a similar effect. The surface of the crack being very irregular, it was difficult to fit the pieces exactly together. Otherwise local tensions and changes of curvature were easily produced by which the image was deformed and the focus of parts of the lens changed. Continued wearisome experiments yielded at last an adjustment sufficient under the circumstances.

The lens gives now with short exposures a well defined, nearly circular, photographic image of stars of the first and second magnitude, and admits adjustment of the focus to $0{\cdot}2^{mm}$. In its former perfect state Mr. Rutherfurd obtained a trail on the photographic plate of stars of the third to the fourth magnitude, as of several stars in the Pleiades. The image of the broken lens does not seem to have the same concentrated sharpness; only slow moving stars, fainter than third magnitude, leave a trail. However, with exposures of eight minutes stars of the ninth magnitude, of white color, give a photographic impression; this result does not seem to have been surpassed formerly.

The greatest difficulty in stellar photography is to make the image on the plate stationary during a long exposure. The steadiness is absolutely necessary for the production of circular images; the images must be circular, because in elliptically lengthened images the eye cannot fix the center with the sharpness required for the measurements. Employing even the most perfect clockwork, the steadiness of the image is affected by the effect of the atmospheric refraction, by the variations in the refraction produced by disturbances in the atmosphere, and by the increase of refraction dependent on the zenith-distance.

The photographic image of stars is circularly spread by prolongation of exposure; this is principally the effect of the scintillating motion of the image, not of want of definition, as its amount depends on the state of the atmosphere. Bond has

found the increase of the area of the image proportional to time. This admits the explanation of the scintillating motion as consisting of transversal vibrations round the central position in all azimuths, and with *uniform* velocity. When the state of the atmosphere produces a strong scintillating motion, the images of bright stars become very large by long exposures, and faint stars do not produce any impression. In great zenith-distances another obstacle combines with the increased scintillation, the strong absorption of chemical rays by the atmosphere.

The increase of refraction depending on zenith-distance for an exposure of eight minutes, is computed in right ascension and declination for declinations from +20° to — 80° for Cordoba, southern latitude 31° 15′ 30,″ thermometer 20° C, and barometer 725 mm.

Differences of refraction.

Interval of Hour-angle,	+20°		+10°		0°		−10°		−20°		−30°		−40°		−50°	
	a	*δ*	*a*	*δ*	*a*	*δ*	*a*	*δ*	*a*	*δ*	*a*	*δ*	*a*	*δ*	*a*	*δ*
	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
0°– 2°	0·00	0·09	0·00	0·07	0·00	0·07	0·00	0·08	0·02	0·13	0·58	0·48	0·02	0·14	0·00	0·07
7°– 9°	0·11	0·67	0·11	0·57	0·14	0·56	0·23	0·62	0·51	0·77	1·54	0·34	0·63	0·68	0·17	0·39
13°–15°	0·34	1·18	0·33	0·97	0·38	0·90	0·55	0·93	0·97	0·92	1·61	0·29	1·08	0·64	0·46	0·62
28°–30°	1·51	2·63	1·30	1·95	1·29	1·58	1·23	1·50	1·69	0·94	1·88	0·36	1·65	0·29	1·17	0·63
43°–45°					2·75	2·37	2·33	2·01	2·50	1·17	2·39	0·59	2·19	0·04	1·79	0·38

Only the component of the refraction in right ascension can be reduced to less than 0″1, by retarding the clock by the mean amount, and for intervals of 8m within the given limits (with exception of the zenith-stars near culmination). The corrections of the clock per hour are:

Interval of Hour-angle,	+20°	+10°	0°	−10°	−20°	−30°	−40°	−50°	−60°	−80°
	s.	s.	s.	s.	s.	s.	s.	s.		
0°– 2°	0·00	0·00	0·00	0·00	0·01	0·33	0·01	0·00	0·00	0·00
7°– 9°	0·06	0·05	0·07	0·12	0·27	0·59	0·41	0·13	0·08	0·06
13°–15°	0·18	0·17	0·19	0·28	0·52	0·93	0·70	0·36	0·22	0·15
28°–30°	0·80	0·66	0·64	0·63	0·90	1·08	1·08	0·91	0·74	0·66
43°–45°			1·37	1·18	1·33	1·38	1·43	1·39	1·32	1·38

The component of refraction in declination cannot be eliminated. But the table shows that a double exposure of eight minutes can be made for all stars in which the motion of the image of the central star is less than 0″2 or 0·004mm on the photographic plate. The field comprehends a circle of 80′ diameter; however, the difference of the motion of stars near the border, and of the central one, is always less than 0.″1. The favorable time for taking photographs is for north culminating stars near culmination, for stars culminating near the zenith at some distance from culmination, for south culminating stars near

culmination, or at greater hour-angle, when the parallactic angle is near right angle.

As the circumstances have been utterly unfavorable, the lens being broken, the clockwork not of sufficient delivery, the results of the enterprise could not fulfill the legitimate expectations of the liberal originators.

The objects of the southern heavens are numerous and glorious. I selected and photographed some twenty star-clusters, most of them in the constellation Argo, some in Canis Major and Scorpio. The cluster near Carinæ Argus gave a hundred and twenty-three stars on the photograph in the most favorable night. The Pleiades, the richest northern group, did not yield to Mr. Rutherford more than forty-five stars; in fact, the Pleiades do not contain within 40′ round Alcyone more than seventy-five stars, inclusive of the tenth magnitude. The groups near ρ Argus and Lacaille 4375 Argus gave about sixty stars; four other clusters t_2 Carinæ, Lac. 4145, Lac. 3134 Argus, Lac. 7478 Scorpionis about forty stars; altogether twenty-seven clusters, about eight hundred stars.

The elaboration of the results which the plates are capable of giving has been reserved to Dr. Gould.

The Argentine Government is going to provide a new photographic lens for the National Observatory, and has asked me to continue the experiments with the new lens.

Cordoba, March 8, 1873.

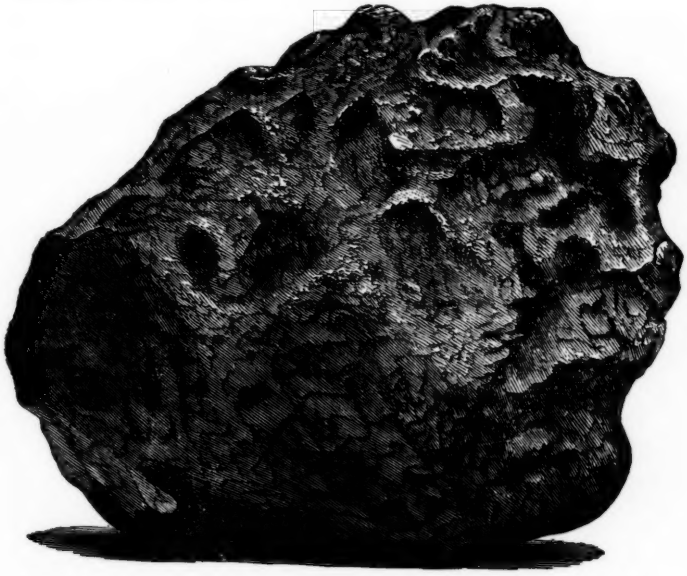
ART. IV.—*On the Meteoric Iron found near Shingle Springs, Eldorado County, California;* by B. SILLIMAN.

(Read before the National Academy of Sciences, Washington, April, 1873.)

AN Eldorado meteoric mass was found by the writer in March, 1872, in the cabinet of Mr. W. H. V. Cronise, of San Francisco, where it was placed by its discoverer, Mr. James H. Crossman, who in 1871 rescued it from the forge of a smith at Shingle Springs, California. It was found in 1869 or '70, in a field belonging to the same smith, about half a mile from the town named. It is said to be the first meteoric mass discovered in California. Mr. C. F. Watkins of San Francisco has photographed this specimen of the natural size, and from this photograph the accompanying figure has been reduced to one-third the linear dimensions of the original.

The mass was intact when I first saw it, and weighed about eighty-five pounds avoirdupois. It was flattened upon one side and presented the usual familiar features of iron meteors. It has since been cut in several sections, one of which (which was

exhibited with this communication) shows a cross section measuring 12×18 centimeters. The section is approximately a semicircle, having the flattened side for its diameter, with the outline and exterior coating perfectly preserved on all sides. Its weight was over 800 grams. The largest dimensions of the entire mass were about 24 and 29 centimeters.



This meteoric mass is remarkably homogeneous in structure and singularly free from included minerals. Only two very small masses of pyrites, of 3 and 5 millimeters diameter, are visible on one side of the slab, and exteriorly I could detect no heterogeneous substance. When the surfaces of the section exhibited were reduced in the planing machine, it was observed that the exterior or crust was so much harder than the general surface of the section as to cause the tool to rise a little, thus leaving a distinct margin slightly elevated above the adjacent parts, and of a whiter color. This hardened crust had a depth of four to five millimeters.

The density of this iron, determined on a mass of over 750 grams in weight, is 7·875, while the density of the shavings cut by the planing tool from the same mass is 8·024, showing a condensation of 0·149 by this mechanical process. This density (of the mass) is above the average specific gravity of meteoric iron, owing probably to its large percentage of nickel, which,

as will be observed, by reference to the accompanying analysis, is more than twice the average amount of that metal found in other meteoric irons.

The crystalline structure of this mass is obscure. The Widmannstättian figures are not developed on it by etching, although a confused granular structure was evident after this process. Wishing to test this point thoroughly, I consulted Mr. John E. Gavit, of the American Bank Note Company, in New York, who is well known for his microscopic and other scientific tastes. Mr. Gavit very kindly tried all the resources known to the engraver's art with a view to develop, by etching this iron, a surface from which its curious cryptocrystalline structure could be transferred to paper by printing. All these attempts have proved unsuccessful. The etched surface, however, examined with a lens, shows a reticulated structure with numerous brilliant points, and V-shaped lines, but so small that when charged with ink the impression upon paper is only a muddy tint. The specimen exhibited shows this peculiar structure developed in four compartments by different etching agents. Some of the printed impressions taken from this surface were also exhibited.

An attempt to develop this cryptocrystalline structure by the aid of a fine "tint," laid on an etching ground by a ruling machine and bitten in; and also by a medallion ruled in orthographic projection, upon which the crystalline lines, it was hoped, might appear in symmetrical form, was not more successful than the other trials. Thus it appears practically hopeless to transfer to paper, by printing, a structure which may yet be clearly seen by the lens.

The suggestion, made long since by Berzelius, that the Widmannstättian figures were due to the segregation of the nickel alloy, in lines of the octahedron, which the etching developed, owing to the inferior solubility of the alloy as compared with the pure iron, seems to meet no support from this mass, in which the uncommonly high percentage of nickel would naturally lead us to expect a proportionate clear development of the crystalline structure. Is it not rather the probable solution of this structure that it is due to the length of time during which the meteoric mass is kept at a high temperature, while slowly cooling? Under such conditions, the molecules can rearrange themselves in symmetrical forms, and over broad surfaces. In the mass before us, it would appear from what has been said of the crust, that the heat did not penetrate to a greater depth below the surface than 4 or 5 millimeters.

The Cape of Good Hope iron analyzed by Uricochœa resembles this both in the absence of Widmannstättian figures, and in its high proportion of nickel; but its cobalt is much

larger, and there are only five elements found, in place of twelve in the California iron.

The following analysis was made upon the clean shavings cut from the entire surface of the section by the planing tool, thus securing a perfectly fair average sample. The analysis was made by Mr. F. A. Cairns, assistant in the School of Mines, Columbia College, whose constant devotion to the analysis of iron gives to his work on this metal great trustworthiness.*

Analysis.

Iron	81·480	Calcium	0·163
Nickel	17·173	Carbon	0·071
Cobalt	0·604	Silicon	0·032
Aluminium	0·088	Phosphorus	0·308
Chromium	0·020	Sulphur	0·012
Magnesium	0·010	Potassium	0·026
	Total,	99·987	

Of the twelve elements quantitatively determined by this analysis, aluminium, calcium, and potassium have been rarely observed in meteoric iron—meteors free from silicates—while the absence of copper, tin, manganese and sodium will be noticed.

No room is left, it will be observed, by this analysis for any notable quantity of occluded gases, for which no search was consequently made.

* The plan of analysis adopted by Mr. Cairns was as follows:

For nickel, cobalt, aluminium, magnesium, calcium, silicon, ten grams were dissolved in hydrochloric acid and chlorate of potassa, and the solution evaporated in platinum, etc.

In the filtrate, the iron and alumina were removed by double precipitations by acetate of soda, and the alumina determined by fusion in silver with pure soda, etc.

From the filtrate, the nickel and cobalt were precipitated by sulphide of ammonium, (the filtrate being acidified by acetic acid, and boiled to recover nickel in solution in the sulphide of ammonium). The sulphides were then dissolved, and the cobalt precipitated by nitrite of potassa, and determined as double sulphate of potassa and cobalt, and the nickel precipitated as hydrated protoxide. In the filtrate from the sulphides, the lime and magnesia were determined as usual.

The iron was determined in a separate portion of the sample, volumetrically.

The chromium was determined in the residue of 20 grams, insoluble in cold dilute hydrochloric acid.

The carbon was determined by dissolving 10 grams of iron in neutral sulphate of copper, and then the precipitated copper by chloride of copper and hydrochloric acid; filtering through asbestos and oxidizing the carbon with chromic and sulphuric acids, by what is commonly known as Elliott's process, really a modification of a process adopted by Prof. Rogers, of the University of Virginia, in 1848. (See Am. Jour. of Science for 1848; also Am. Chemist, Oct., 1871, p. 140.)

For the phosphorus and sulphur, 10 grams were dissolved in hydrochloric acid and chlorate of potassa, and evaporated to extract silica. The solution was then divided, and in one half the sulphuric acid was precipitated by chloride of barium, as usual. In the other half, the phosphoric acid was determined by molybdate of ammonia, after expelling all chlorine, as usual.

The potassium was determined in 10 grams of the iron by the usual process for alkalies; dissolving, precipitating by baryta, etc.

The amount of nickel in this iron is exceptionally large. In comparing all the analyses conveniently accessible, I find only one other meteoric iron showing so much nickel. That of Greenville, Tenn., by Clark, has Ni 17·10 Co 2·04 = 19·14, which is the highest before recorded, so far as I can discover. That of Tazewell County, Tenn., by Smith (this Jour., II, xix, 155), has Ni 14·62 — 15·02 and Co 0·43 to 0·50; that of Cape of Good Hope, by Uricochœa (*Rammelsberg, Mineralchemie*, pp. 919–920), contains Ni 15·09 and Co 2·56 = 17·65, almost identical with the sum of Ni and Co in the Shingle Springs = 17·777 per cent.

The Clairborne, Ala., iron, analyzed by Jackson (this Jour., I, xxxix, 335, and quoted by Gmelin, v, 395 of Cavendish ed.), gave him Ni 24·708—27·708, but this was subsequently reduced by A. A. Hayes (this Jour., I, xlviii, 153) to Ni 12·665 per cent. Very few of the analyses have obtained over 10 per cent of Ni, and an average of this element in some 80 analyses compared by me, is not over seven and a quarter per cent.*

ART. V.—*Contributions to Mineralogy;* by ALBERT R. LEEDS, Prof. of Chemistry in the Stevens Institute of Technology.

I. *A Hydrous Unisilicate approaching Pyrosclerite.*

OCCURS at the so-called Magnesia Quarries, from which the deweylite, at one time largely employed in the manufacture of Epsom salts, was quarried, in the Bare Hills, Md. Since this mineral, in common with the other hydrous unisilicates of a similar character, is to be regarded as most probably one of the results of a process of alteration which has operated powerfully upon the rock masses constituting the Bare Hills, it is important to mention exactly its method of occurrence, which I do from a personal examination of the locality. It is found in a nearly vertical seam several inches wide, between walls of deweylite on one side and talc on the other: the deweylite graduates into albite; the talc is bounded by common serpentine with folia, whose surfaces are normal to the line of contact with the talc.

H. = 1·5–2. G. = 2·558. Color grayish, inclining in some places to bronze-yellow. Golden luster on fresh cleavage surface. Translucent in thin folia; transmitted light, brownish-yellow. Brittle. Orthorhombic. Largest crystals from this locality 3^{mm}· long in the direction of the macrodiagonal. Basal cleavage eminent. Optically biaxial. Heated in closed tube yields much water of a neutral reaction, and exfoliates vigorously. The folia are pearly-white and opaque. Decomposed by hydro-

* A brief notice of this meteoric iron was published by Prof. C. U. Shepard, in this Journal for June, 1872.

chloric acid, the silica being left behind in microscopic colorless scales. Iron reaction with microcosmic salt. With calcic chloride in spectroscope, the lithium band. Composition:

	I.	II.	Mean.	Calculated.	O ratio.	
SiO_2	36·03	35·84	35·99	37·45	19·195	6
Al_2O_3	9·19	9·85	9·52	14·27	4·436	2
Fe_2O_3	5·48	5·21	5·35		1·605	
FeO	0·94	1·21	1·08		0·240	4
MgO	33·05	32·93	32·94	33·30	13·176	
Na_2O	0·41	0·41	0·41		0·106	
Li_2O						
H_2O	14.66	14·53	14·60	14·98	12·978	4
	99·76	99·98	99·89	100·00		

Or for the bases and silica, O ratio = 19·56 : 19·19. This makes the mineral a hydrous unisilicate of the formula $(\frac{3}{4}\dot{M}g^3 + \frac{1}{4}(\dot{A}l,\dot{F}e)^2\breve{S}i^3 + 4\dot{H}$. It will be seen by a comparison of this formula with that of pyrosclerite $(\frac{3}{4}\dot{R}^3 + \frac{1}{4}\dot{A}l)^2\breve{S}i^3 + 3\dot{H}$, that it differs from the latter by one molecule of water only.

II. *Talc pseudomorphous after Pectolite.*

Occurs in the veins of calcite which traverse the trap rock in the vicinity of the Bergen Hill Tunnel, Hoboken, N. J. Structure radiate, forming arrow-headed masses. Folia easily separable, brittle and varying in length from 1 to 50^{mm}; smooth to the touch, satin luster on faces of folia; crumbling quickly to an impalpable powder when crushed in the mouth, the powder being destitute of grittiness and with a faintly alkaline taste; subtranslucent on their edges, becoming translucent when wet.

H.=2·5. G.=2·565. Heated in closed tube blackens, gives much water, the vapor of which turns litmus paper blue, fumes when brought near a rod moistened with hydrochloric or acetic acid, and when collected by distillation gives with Nessler reagent a strong reaction of ammonia. Partially decomposed by hydrochloric acid, with separation of aluminic and ferric oxides. Iron reaction with microcosmic salt. B.B. darkens, then becomes white, slightly exfoliates and fuses at the ends of thin splinters to a greyish-white enamel. Gives with cobalt solution a pink color on ignition. Composition:

	I.	II.	Mean.	O ratio.
SiO_2	60·54	60·57	60·55	32·293
MgO	26·46	26·67	26·56	10·624
Al_2O_3	1·06	0·98	1·02	
FeO	0·70	0·74	0·72	
MnO	0·55	0·76	0·65	10·401
CaO	1·19	1·63	1.41	
H_2O	9·52	9·09	9·30	
	100·02	100·44	100·21	

O ratio for $\dot{R}$, $\breve{S}i$ and $\dot{H} = 1:3:1$, corresponding to the hydrous silicate $\dot{M}g^2\,\breve{S}i^3 + 2\dot{H} = SiO_2$ 60·8, MgO 27·0, H^2O 12·2 = 100. While closely approaching talc in its physical characters, this pseudomorph after pectolite is near sepiolite in its chemical composition.

III. *Leucaugite from Amity, N. Y.*

Occurs in rounded, undefinable prismatic crystals and coarse grains, along with seybertite, in calcite.

H. = 5·5. G. = 3·26. Luster vitreo-resinous, bright on cleavage surface; dull on fracture; color light-brown; streak white; translucent in thin splinters; fracture coarse granular; very brittle; B.B. fuses slightly on the edges becoming greyish-white; feeble iron reaction with microcosmic salt.

It resembles in color and general appearance the spinel occurring along with chondrodite and plumbago at Warwick, Orange Co., N. Y. It is likewise almost identical in composition, color, etc., with the leucaugite from Bathurst, W. Canada, described and analyzed by Prof. T. S. Hunt (Dana's Min., 5th ed., pp. 216 and 218). Composition:

		O Ratio.		O ratio.
SiO_2	50·05	26·693	30·030	2
Al_2O_3	7·16	3·337		
Fe_2O_3	0·56	0·504	15·093	1
MgO	14·48	5·792		
CaO	25·63	7·321		
H_2O	1·66	1·476		
	99·54			

This composition is that of a bisilicate of lime and magnesia, with some of the silica replaced by alumina. It is, therefore, an aluminous pyroxene of the formula $(\dot{C}a, \dot{M}g)\,(\breve{S}i, \breve{A}l\,\ddot{\imath})$, which is the formula of leucaugite.

IV. *Mineral associated with Corundum and approaching Ripidolite.*

Occurs at the Lesley farm (corundum locality), now owned by Messrs. Pusey & Ball, in Newlin Township, Chester Co., Pa. Encountered in a mass of about 30 lbs. at the borders of a great mass of corundum, of which about 60 tons (Jan., 1873) have now been laid bare. In the specimen from which the material used in the analysis was taken, the corundum is bordered by a soft mineral, which Dr. Isaac Lea pronounces "lesleyite" (App. Dana's Min., p. 18). It contains both lithia and potash. As it recedes from the corundum, the lesleyite alters in character, becoming white and diminishing in its potash percentage. The mineral analyzed contained no potash whatever, but abundant lithia.

H.=1·5–2. G.=2·718. Massive; color light olive-green; streak greenish-white; powder greasy; entirely decomposed by hydrochloric and sulphuric acids, the silica being left behind in an amorphous powder; in closed tube yields water; B.B. turns yellow from oxidation of ferrous oxide, but quite infusible; does not exfoliate; turns flame bright yellow (soda); with calcic chloride paste strong lithium band in spectroscope. Composition:

		O ratio.	
SiO_2	30·62	16·331	4
Al_2O_3	21·73	10·126	3
Fe_2O_3	0·42	0·378	
FeO	5·01	1·113	
MgO	29.69	11·876	4·84
Li_2O	0·11	0·058	
Na_2O	0·14	0·036	
H_2O	12·26	10·898	3·23
	99·98		

The small percentage of ferric oxide is due to a superficial oxidation of some of the ferrous oxide in the mineral, and is consequently calculated as protoxide. The presence of lithia, which I have not been able to detect in any of the accompanying ripidolites, and the unsatisfactory aspect of the oxygen ratio, forbid not only the supposition that this is a variety of ripidolite, but also that it is a new and independent mineral. It seems more probable that it is composed of one or more secondary products derived from a process of alteration. I am indebted for this mineral to the kindness of Dr. Isaac Lea. After arriving at these results, I learned from Dr. F. A. Genth that these minerals, associated with corundum, had been for a long time past the object of his studies, and we shall look with the greatest interest to the results of his investigations in this direction.

V. *Moonstone from Media, Delaware Co., Pa.*

H.=6·5. G.=2·59. Brilliant blue reflections from surface of principal cleavage; finely striated upon second cleavage surface; white, imbedded in white granular albite; closely resembles the peristerite of Canada.

Composition: SiO^2 67·70, Al^2O^3 19·98, Fe^2O^3 trace, CaO 1·47, MgO 0·11, Na_2O 8.86, K_2O 1·36, Ign. 0·08 = 99·56. Oxygen ratio for $\dot{R}$, $\ddot{R}$ and $\ddot{S}i$ = 2·951 : 9·310 : 36·126 or 1 : 3 : 12, which assigns to this variety of moonstone the normal composition of albite.

VI. *Antholite from the "Star Rock," Concord, Delaware Co., Pa.*

H. = 5–5·5. G. = 3·20. Luster vitreo-pearly; color yellowish-grey; streak dirty-white; broadly bladed and sub-

fibrous, with evidence of incipient alteration; translucent; doubly refracting. An analysis gave:

		Oxygen ratio.	
SiO_2	55·12	29.396	} 29·652
Al_2O_3	0·55	0·256	
FeO	8·20	1·822	}
MnO	0·33	0·074	
CaO	0·75	0·214	
MgO	31·18	12·472	} 15·152
K_2O	1·01	0·170	
Na_2O	1·55	0·400	
H_2O	2·21	2·044	}
	100·90		

It is, therefore, a somewhat altered and hydrated bisilicate of lime and iron of the general formula (Mg, Fe) Si. In other varieties of this mineral, which in common unfortunately goes by the name "anthophyllite," the departure from the normal composition is still wider.

VII. *Wernerite from Van Arsdale's Quarry, Bucks Co., Pa.*

Occurs interpenetrated with sphene, cryst. graphite, pyroxene and oligoclase. H. = 5·5. G. = 2·708. Luster greasy; white, but with faint greenish tinge from admixed impurities; very translucent; structure columnar massive. Composition: SiO_2 47·47, Al_2O_3 27·51, Fe_2O_3 trace, MgO 1·20, CaO 17·59, Na_2O 3·05, K_2O 1·40, H_2O 1·48 = 99·70. Oxygen ratio for R, Al and Si = 6·53 : 12·82 : 25·316 = 1 : 1·97 : 3·88. This ratio is unusually near the mean oxygen ratio of the least altered varieties of wernerite, and there appears no good reason for giving to this variety of scapolite from Van Arsdale Quarry, as has usually been done, the name of ekebergite.

Stevens Institute, April 7th, 1873.

ART. VI.—*Indian Mounds and relics on the Coast of Oregon;* by H. A. CHASE.

THE Indian tribes that once inhabited the coast line of the northern portions of California and the southern of Oregon have almost entirely disappeared, if we except the powerful tribe of the Klamaths, still living on the river of that name. The reasons for this disappearance are to be found, not only in the usual destiny of the aborigine to fade away when brought into contact with the strong civilization and also the strong vices of the white—but war, both between different tribes, and

between the Indians and the white settlers. The particular section of coast referred to was depopulated after the great war of 1856, called the Rogue River war. The coast tribes generally participating in this were either destroyed by the enraged settlers, or at the conclusion of the fight transferred to the different reservations by the General Government. They have, however, left behind them relics of ages of occupancy of favorite haunts, which offer an opportunity to trace their gradual improvement from remote times and their after decline as the influence of the whites became general.

These relics are in the shape of mounds, consisting of the debris of many years, perhaps centuries, of occupation, and the stone and other implements found in their graves. The traditions of the few Indians still remaining, and the stories told the first settlers, all point to the fact that a constant state of predatory warfare went on between the different tribes in the early times. The chief of a class or family, then, in selecting a spot for his encampment, would have several points in view. First security from a sudden surprise on the part of inimical tribes; whence he would select some prominent knoll or hill which would offer a view both up and down the coast, and be far enough away from the forest to prevent an ambush. Second, a supply of food and water; not difficult to find, since the rocky coast afforded him an abundant supply of mussels, and other shell-fish easily obtained at any point; salmon in the season were abundant in the small streams, and cod, bass and halibut were found in schools, around the outlying rocks and reefs, which also afforded a shelter for the seal and sea lion; the great fir and redwood forests that, commencing on the slopes of the coast range, extended into the interior, were filled with elk, deer and bear; the marshy meadows near the streams afforded him camas root, and the sea beach a glutinous and edible sea weed; finally, the acorn of the chesnut oak, ("Quercus densiflora,") and the nut of the laurel, ("Oreodaphne Californica,") were also used.

Wherever, then, we find a prominent knoll commanding a good view, with a sand beach near it, and outlying rocks, we find the remains of the Indian occupancy. Passionately attached to a spot once chosen, especially after any of the tribe had been buried there, they would live and die on their mound, never venturing farther from it than was necessary to procure food.

At first it is probable that their habitations were holes dug in the ground, and covered over with brush or drift wood; these were afterward improved by puncheons, or rough-hewn planks from the cedar or redwood. The shells of the mussels and clams, the bones of sea-lions, bear, deer, and other animals and fish consumed, were thrown outside the hut. When an Indian

died, an excavation was made in this debris, and he was placed in the grave in a sitting posture, facing the east. His arms, trinkets, all that he possessed, were then disposed about his person, the grave was filled up, and a rude fence erected around it. His house, or hut, was then burned down, and the ashes cast over the grave.

Of course in the lapse of years, the accumulation of debris on the mound was immense, and completely covered the original hill often to a depth of 25 or 30 feet.

An Oregon farmer owning the land on which one of these mounds was situated, cut a portion of it away for the purpose of getting a secure foundation for his house, and also to use the shells and debris for manuring his lands.

Being on the spot, I was afforded an excellent opportunity of observing the formation of the mound, and also of securing the different stone implements to be described. The vertical section exposed was about twenty-five or twenty-six feet. The original ground being a stiff clay, the accretions were easily distinguished from it. For the first two or three feet, the shells and bones were so far decomposed that they formed a fine black loam. The articles found in this stratum were of the rudest construction; and, of course, only those of stone remained In the next stratum, however, articles of bone and ivory and an occasional perfect skull were exhumed, while ten feet from the surface the skeletons were intact, and articles of bone and ivory and even of wood perfect.

The articles obtained may be divided into four classes, and in giving a description of characteristic specimens of each, I shall endeavor to account for its use, basing my information on the present habits of the old Indians remaining and the traditions of the whites. These classes are, first, objects of superstition and personal ornament; second, implements used in preparing food; third, implements of warfare and the chase; and fourth, those used in manufacture.

Of the first class, the most remarkable are knives, or swords, of black and bluish obsidian. The bones found with these implements were of unusual size, the skull being especially large. The owner was probably a chief, or perhaps a medicine man or doctor.

One of these obsidian knives is double edged and double ended, in shape not unlike a Greek sword, $14\frac{3}{4}$ inches long, 2 inches broad at one end, $1\frac{3}{4}$ inches at the other, tapering toward both ends and edges, and $\frac{1}{4}$ of an inch thick at the center. This knife is most carefully knapped, and considering the brittle character of the material, must have required no mean amount of ingenuity and patience to fashion. A second is of the same material, but not so large, being $8\frac{1}{2}$ inches long with a uniform

width of one inch, tapering to a point and to both edges. A third smaller one, but of the same shape, is composed of red jasper, mottled with black. Others, smaller still, are of green jasper, and of obsidian of a bluish cast. These knives could not have been used for practical purposes, as too much labor has been bestowed on them (considering the brittle character of obsidian); then again there is no place where they could have been grasped without injury to the hand. Now at the present time obsidian is highly valued by the Klamath Indians, and an arrow or spear head of any size fashioned of it will command a high price, either in "Siwash," i. e., alacachic or Indian shell money, or in gold and silver. (The Klamaths at the present time are well armed with both muskets and pistols, and have discarded the use of stone for weapons.) The value attached then to these arrow and spear heads is a purely fictitious one, and connected with the superstition that one of these stones in the possession of a family will ensure to it health and a permanent occupation of a favored spot. These knives were probably held in high value, and brought out to display the wealth of the owner on some festive occasion, such as a medicine dance, etc. Prescott mentions the knives of obsidian used by the priests of the fire-god in Mexico, in their abhorrent human sacrifices. Found with the knives were several polished stones, oblong in shape, rounded on the sides, and flattened on the upper and lower surfaces. They are of an exceedingly hard black rock not found in the immediate vicinity, and as the polish is equal to that of a lapidary of to-day, one is at a loss to conceive how it could have been done, unless by the attrition of another rock or stone of equal or superior hardness, and by immense labor.

Other articles coming under this head are flattened pieces of bone with carved edges, used probably as ear-rings, pipes of slate and sandstone with straight tubes, whistles formed of the thigh bones of birds, etc.

Of the second class, a great variety of pestles and mortars were found, those of the lower strata being exceedingly rough in shape, but as the upper layers were approached becoming more regular and some of them even artistic in fashion. The mortars are simply a round stone of trap or greenstone, selected from the beach most probably; the center of this stone is hollowed out to form a receptacle for the article to be powdered. The pestles are of all sizes and forms, the most frequent being a shaft of hard serpentine or sandstone, ending in a little ball.

One of them, however, is composed of dark greenstone exceedingly hard, and is well polished. In shape it is like a bell, being full below and tapering to the handle, which ends with an ornamental top.

These implements were undoubtedly used then, as they are now by the Klamaths, in the preparation of acorn food. The nuts being roasted, were divested of the outside shell and pounded into meal in the mortars by the squaws. The meal mixed with water was then baked into cakes before an open fire, and formed a not unpalatable substitute for flour.

Of the third class, viz., implements of warfare and the chase, a great variety was found. The arrow and spear heads are fashioned with great care out of jasper, flint, and obsidian. There seems of the former to be two classes, one most probably used in hunting, the other for war. The former are larger and rougher in shape, the latter delicate in form and of small size; the latter were most likely poisoned when used, the method of obtaining the poison being to capture a rattlesnake alive, and by irritating it, induce it to thrust its fangs into a putrid deer's liver, in which the arrow heads were placed, and removed just before a battle. The spear heads were of two kinds, stone and ivory, the latter made from the teeth of the sperm-whale and sea-lion, which were occasionally stranded on the beaches. These were evidently intended for fish alone.

The stone spears are about three inches long, fashioned from black and white flint, also from jasper of different colors. The bows used with these arrow-heads, and the handles of the spears, had rotted away, but there is no doubt but that they were made of the northern yew, "*Taxus brevifolia*," which is the material still in use by the Klamaths. It is a tough elastic wood of close fibre and dark red color. The favorite method of taking elk was to dig pits, from 15 to 20 feet in depth, in the trails used by the animals in traveling from one pasture to another. In the bottom of the pit sharpened stakes were planted, and on the top a light covering of branches and leaves. When the animal fell into the pit the stakes impaled him.

It is dangerous to travel at the present time over the country in the vicinity of the mounds, unless the beaten trails are kept, on account of these pits, which are concealed by the luxuriant growth of brake and fern, which covers all open spaces on the sea coast of Oregon.

Of the fourth class, several stone adze handles were found. These were made of sandstone, one of dark greenstone. The tops were curved and rounded to a point, and protruding knobs afforded an opportunity of lashing a knive or adze of flint to the handle.

These were probably used in hollowing out the canoes. A log of redwod being selected from the beach drift, free of knots, a fire was built in the center, and as the wood charred, it was chipped away, until a shell was formed; the outside was then shaped in the same way. The canoe in use at present by the

Klamaths will stand a very heavy sea without upsetting. Before the introduction of iron, it was a work of many weeks to fashion a canoe, and once completed it was regarded as a valuable piece of property. The canoe is always burned over the grave. Under this head would also come needles of bone and ivory. These were used in the manufacture of nets, the material being a tough grass.

The most remarkable article, however, of this class was exhumed from a mound at the mouth of the Chetko River, some five miles below those from which the implements above described were taken. It is a brass hatchet or adze. It is about 4 inches long by 2 at the head and 3 at the cutting edge, and $\frac{1}{4}$ of an inch thick. It bears evident marks of being hammered out, and the edge shows continuous use. The perforation for the handle is in the flat part of the hatchet, and not in the edge as in our tools. The depth at which this was found, and the character of the deposit over it, precludes the idea that it could have been introduced by the whites, whose settlement does not date back more than thirty years.

There are large deposits of native copper in the mountainous country at the head of this river, and ores said to be zinc have been discovered. Whether then it was manufactured from these ores, which would argue a degree of skill that is not evidenced by the other implements, or from some copper or brass picked up from a wreck, possibly of one of the early Spanish navigators, is a question. There have been, it is well known, a number of Japanese junks driven over and wrecked on the Pacific coast. It is possible the material may have been obtained from one of them. In this connection a curious and well authenticated legend (that is familiar to the remaining Indians of the Chetko tribe, one or two families of whom still exist) will bear relation. The Chetkos say that many seasons ago their ancestors came in canoes from the far north, and landed at the river's mouth. They found two tribes in possession, one a warlike race, resembling themselves; these they soon conquered and exterminated. The other was a diminutive people, of an exceedingly wild disposition, and *white*. These called themselves, or were called by the new comers, "Wogies." They were skillful in the manufacture of baskets, robes, and canoes, and had many methods of taking game and fish unknown to the invaders. Refusing to fight, the "Wogies" were made slaves of, and kept at work to provide food and shelter and articles of use for the more warlike race, who waxed very fat and lazy. One night, however, after a grand feast, the "Wogies" packed up and fled, and were never more seen. When the first white men appeared, the "Chetkos" supposed that they were the Wogies returned. They soon found out

their mistake, however, but retained among themselves the appellation for the white men, who are known as Wogies by all the coast tribes in the vicinity.

In concluding this imperfect sketch of the Oregon mounds, I would express the hope that they be made the subject in the future of an exhaustive exploration by scientific men familiar with Indian habits, confident that they will repay such a search, and that the discoveries made will throw much light on the history of the race, now so nearly extinct.

ART. VII.—*A local Thunder Storm presenting evidence of strong wind blowing outwardly in all directions from its center;* by GEORGE SUTTON, M.D., Aurora, Indiana.

(Read before the Cincinnati Society of Natural History.)

THERE is a phenomenon connected with our local thunder storms occasionally occurring in summer, and doing immense damage to the growing crops, which I think has not received the attention that it deserves, as scarcely any allusion is made to it in our works on meteorology. I refer to a strong wind suddenly blowing *outwardly* in all directions from under a storm cloud during an unusually heavy fall of rain, the wind subsiding as the cloud disappears; the cloud itself remaining about stationary, having concentrated and nearly dissolved over the same place. This phenomenon is local, being independent of the great storms which sweep over our country; neither does it present the evidence of a cyclone or tornado, but occurs on a still sultry day in summer, when masses of cumuli, after gradually concentrating at one point, rapidly dissolve and pour down immense torrents of rain, sometimes intermingled with hail, accompanied with this strong wind blowing outwardly to every point of the compass from the body of the storm. Being accustomed daily for many years to record meteorological observations, I have noticed, at different times since 1840, evidences of this outward wind occasionally accompanying our local thunder storms, although I never have given the subject careful investigation until recently.

On the 26th of August last I had an opportunity of witnessing the formation and progress of a storm of more than usual violence, which, after careful examination, has presented the most conclusive evidence of this outward blow of wind. This storm was on the south side of Langhery Creek, within two minutes and a half of Aurora, Indiana. The morning of the 26th was clear and beautiful. At 7 A. M. not a cloud was to be seen. The atmosphere was perfectly calm, though the vane was pointing toward the N.E. I marked the thermometer that

morning 76, the barometer 29·50 in.; the dry bulb of the thermometer 88, the wet 29; these last instruments were under cover in my office. At 2 P. M. cumuli were seen in different directions, with a scarcely perceptible motion from the west. I marked the amount of clouds as six. The atmosphere was calm, the vane pointing toward the S.W. The thermometer 98, although it stood shortly before at 100, the temperature varying as clouds obscured the sun. The barometer stood at 29·49 in., attached thermometer 92, dry bulb of the thermometer 88, wet 82. About 3 o'clock P. M. I noticed heavy cumuli forming to the south of Aurora, in which, shortly after, thunder was heard, and I saw that light rain was falling from one of the clouds near the mouth of Langhery Creek. Black-looking cumuli were forming near this cloud to the west. It was evident that from those clouds there would soon be heavy rain, and in company with one of my neighbors I watched the progress and formation of this storm, hoping, as the ground was dry and parched, it would extend over Aurora. The atmosphere was remarkably still and sultry.

About 4 P. M. these cumuli had united, forming a black massive-looking cloud, which appeared stationary. This cloud was not extensive, as clear sky could be seen all around the horizon under it, except a small portion to the east, where light rain was still falling. A few minutes after 4 (the exact time is not known, as it was not marked) I noticed a number of dark streaks of rain falling from different portions of this cloud: these could easily be seen shading the clear sky beyond; but in a few minutes afterward they had increased so rapidly that the whole cloud from the horizon upward presented a dark and streaked appearance, showing that the storm was fully developed, and that heavy rain was falling; at the same time there was stream after stream of the most brilliant flashes of lightning, followed by heavy peals of thunder. The atmosphere, as I before mentio[n] had been remarkably calm and sultry up to this time. [W]e the storm was at its height a strong wind arose blowing directly from it. This wind at Aurora was not sufficiently violent to blow down or damage the corn in the neighborhood, but it produced a sudden change in the temperature of 29 degrees, from 98 to 69. The cloud rapidly dissolved almost over the same place in which it had formed, and in less than an hour, or before 5 o'clock, the grand mass of cumuli which at first attracted our attention had disappeared and in its place was a narrow cirrus cloud from which light rain was falling; shortly after we could see clear sky again beyond this cloud, showing that the storm had not been extensive. A little after 5 o'clock we had a slight sprinkle of rain at Aurora, scarcely sufficient to lay the dust, which I marked

at three-hundredths of an inch. About 6 o'clock another storm formed to the southwest, about 12 miles distant. In the evening cumuli were seen to the northwest, in which there was occasional lightning. At 9 o'clock I marked the amount of cloudiness as eight cirrus. The vane was pointing to the southeast. Thermometer stood at 76, the barometer at 29 44 in., attached thermometer 82, dry bulb of the thermometer 83, wet do., 79. The mean temperature of the day was 83¼.

The next morning, August 27th, the topic of conversation with every person I met coming from below the mouth of Langhery Creek was about the terrible storm which they had had the day before. It was represented that the corn crop was flattened to the ground and destroyed; trees and fences were blown down, drift wood piled up along the banks of the creek, and fences, in many instances, washed away. The lightning had set fire to a hay stack. One wealthy farmer, residing in the neighborhood, declared to me that immediately after the storm he could have shoveled up a cart load of hail stones. All represented the fall of rain and hail as unprecedented, doing immense damage to the growing crops. I rode down to this neighborhood, and when within half a mile of Langhery I began to see evidences of a severe wind storm. The corn was blown down, every stalk lying parallel in one direction, pointing up the river or to the north. I would here remark that our extensive fields of corn, of thousands upon thousands of acres, during the months of July, August and early part of September, when the corn is rapidly growing and brittle, presents an excellent means, if not the very best, of tracing the direction a severe wind has blown during our local storms. After crossing Langhery Creek I approached the center of the storm, the evidences of its violence becoming more manifest. The corn was flattened to the ground and uniformly lying to the north until we came near to a small stream known as Shingle Creek, three miles below Aurora; here the corn was blown down in different directions and stripped of its blades by the hail. Trees were broken or uprooted, and the kitchen attached to a dwelling-house on the banks of the creek was overthrown. This small stream, which is not more than a mile in length, rose to an unprecedented height, stopping for a time the travel on the Rising Sun road, washing away fences, carrying down great quantities of drift wood, and overflowing the corn fields before it reached the river. At the head of this stream, which seemed to be about the center of the storm, a large amount of timber was blown down. Following the Rising Sun road toward the south, evidences were seen of the violence of this storm from the drift wood, stone and gravel lying along the road left by the little streams which ran down from the hills. Four miles below

Aurora along this road, after passing the center of the storm, I found the corn lying in the opposite direction, toward the south. Still farther the evidence of the storm was less, and at Rising Sun, eight miles below Aurora, there had been no rain. As we came up the river on the Kentucky or east side of the storm, a little above Bellview, we saw evidences again of the violent wind; here the corn is blown to the southeast; as we still came up the river opposite to the storm we found it lying to the east, and at Split Rock, still farther up the river, to the northeast, and on crossing the river at this point we found it lying to the north, as before mentioned. Following around the north side of this storm, the corn stalks were seen lying to the north or northwest. One mile above Hartford, seven miles from the mouth of Langhery Creek on the west side of the storm we found the corn lying to the west. The violence of the wind, however, did not seem to have been as great here as on the north and east sides, but still showed the most conclusive evidence of having blown toward the west. Crossing over to the south side of the storm, to the farm of W. Higbee, and all along the southern border of the storm, we found the corn lying to the south and southeast, while down the center of the storm it was lying in different directions, presenting no regularity. It was along the center of this storm that the hail and rain fell in such immense quantities, scarcely any hail falling around the circumference, and none on the west end of the storm. The effect of this unusual rain-fall will be seen for years from the stone and gravel and logs and driftwood left along the banks of the little streams near the center of the storm. The amount of rain that fell is not known, as there was no measurement made by any person residing within the boundaries of the storm.

This storm was between six and seven miles in length and two or three miles in width, lying almost east and west, extending over an area of about fourteen square miles. It did not come from the west, but formed or concentrated almost directly over the country where it expended its violence. A farmer residing near the center of the storm informed me that he was at work in some woodland near his house, when it began to rain; although a dark cloud was overhead, he could see clear sky around the horizon, and consequently was not expecting much rain; the atmosphere was remarkably still and oppressive. He got under a tree, but in a few moments the rain came down in such torrents, and the wind began to blow with such violence, that he left the tree and ran to the house. Shortly afterward this tree, with others, was blown down. I have received the same statements of the stillness of the atmosphere previous to the commencement of the rain from other persons residing within the boundaries of the storm.

This storm presented no evidence of progressive motion or a whirlwind. The clouds remained stationary, the wind blew in gusts, but in no particular direction along the center of the storm, and outwardly all around its borders. There was no strong wind or sensible evidence of converging forces accumulating this immense amount of moisture over this small section of country, although there must have been an imperceptible movement of the surrounding atmosphere toward this point. It is difficult to account for the accumulation of so vast an amount of moisture in any other way. That there was a strong converging upward current is not sustained by a single fact, nor by the observation of a single individual residing within the boundaries of the storm. The atmosphere was still, up to the commencement of the rain.

ART. VIII.—*The Diagonal System in the Physical Features of Michigan;* by A. WINCHELL, Chancellor of the University of Syracuse.

IN the study of the topographical features of Michigan, our attention has been arrested by the observation of an interesting method in the disposition of the lines of relief and drainage. This method, which has not been heretofore pointed out, may be enunciated as the *Diagonal System.* By this expression we mean to say that the longitudinal axes of the topographical and hydrographical features of the State, especially of the lower peninsula, lie in directions which are diagonals between the cardinal points of the compass. We propose to cite a few facts for the purpose of illustrating and establishing this generalization.

With reference to the surface configuration of the lower peninsula, we divide it into the northern and southern lobes. These are separated from each other by a depression extending from the head of Saginaw Bay, up the valley of the Saginaw and Bad Rivers, and down the valley of the Maple and Grand Rivers, to Lake Michigan. This, which we have styled the Grand-Saginaw Valley,* nowhere attains a greater elevation than 72 feet above Lake Michigan. The highest elevations of the southern lobe are more than 600 feet, and those of the northern 1200 feet above Lake Michigan.

The southeastern watershed of the southern lobe is an elongated axis of relief, stretching through Huron, Sanilac, Lapeer, Oakland, Washtenaw and Hillsdale Counties. None of the streams of the peninsula cross it, though its easterly and

* See Walling's Atlas of Michigan; also "Topographical Data for Michigan" (nearly ready for publication), by the writer.

westerly slopes are deeply furrowed by the streams issuing at right angles with its main trend.

The northern lobe of the peninsula is divided primarily by the deep valley of the Manistee and Sable Rivers, flowing southwesterly and southeasterly into their respective lakes. The southern division is deeply indented by the basin which holds Houghton and Higgins Lakes. The former has an elevation of 589 feet above Lake Michigan. From this lake the Muskegon River, the largest of the peninsula, takes its rise, and flowing southwesterly, marks the position of a broad, deep valley, having, on the southeast an elongated watershed stretching from Mecosta County through Clare and Roscommon into Ogemaw County. This we have designated the central watershed. It has a general elevation of 700 feet, while some of its summits exceed 800 feet. On the northwest of the Muskegon Valley we note three broad summits ranged in a line parallel with the valley and reaching elevations of 700 feet.

The northern division of the northern lobe of the peninsula, embracing the most elevated land south of Mackinac, being the region of the parting of the waters in all directions except the south, has not preserved any marked longitudinality.

We may now direct attention more particularly to the diagonism to which we have referred.* In the lower peninsula, the southeastern watershed stretches 200 miles from northeast to southwest (euroboreally), and the central watershed, 80 miles in the same direction; while the Grand-Saginaw Valley lies in the midst of the intervening region. To this direction conforms the trend of the water-courses from Lake Huron to Lake Erie, the axes of Saginaw and Green Bays, and Great and Little Bay de Noquet, as well as the northern reach of Lake Michigan. Along the same diagonal lie the valley of the Manistee, Muskegon, White and Crockery Rivers, as well as large portions of the valleys of the Pine, Salt, Shiawassee, Cass, Flint and many smaller streams.

In the northwest and southeast (euronotal) direction lie Thunder Bay and the valleys of the Kalamazoo, Little Manistee, Pine, South Branch of Père Marquette, Sable, Rifle, Tittabawassee, Belle, Clinton, Huron and many smaller streams. Even streams

* As our language does not supply the terms for the convenient and brief expression of some of the following ideas, we venture to suggest a few new terms. Lines lying in the direction of the cardinal points of the compass, may be designated as *cardinal*, or *cardinals;* those lying in the angles between the cardinals may be called *diagonal* or *diagonals.* Of the two cardinals, the north-south one may be designated the *meridional*, and the east-west one, the *transmeridional.* Of the diagonals, the northwest-southeast one may be called *euronotal* (from "Euronotus," a southeast wind), and the northeast-southwest one, *euroboreal* (from "Eurus," an east wind, and "Boreas," the north wind). These terms may be used both adjectively and substantively.

whose outlets are east or west of their sources, pursue zigzag courses to their mouths, in order to conform to the diagonal system. The St. Joseph River, from its sources in Hillsdale County, pursues a general southeasterly course to South Bend in Indiana, and then flows northwest to Lake Michigan. The Cass River flows southwest into Saginaw County, and describes a rounded angle toward the northwest, to pursue its course to the Saginaw. The Flint flows southwest 35 miles to Flint, and then northwest 30 miles to the Shiawassee. The Shiawassee flows northwest 35 miles to Owosso, then northwest 35 miles to the Saginaw. The Raisin, traced from its higher tributaries, is found to flow from the southern part of Jackson County, southeast 15 miles, then east-northeast 7 miles, then southeast 7 miles, then northwest 18 miles, then southeast 15 miles to Lake Erie. The Pine River (of the east) flows southeast 28 miles, then northeast 33 miles to the Tittabawassee. This river, from its source to Saginaw Bay through the Tittabawassee, consists of four sections, two almost rigorously at right angles with the other two, and all lying along the diagonals. The Becs Scies (or Betsie) River flows southwest 20 miles, then northeast 15 miles, into Lake Michigan.

Nor are there any considerable streams not included in the foregoing mention, whose valleys conform to the direction of the cardinals. The river St. Clair and a portion of the Detroit constitute an exception to the statement, to which reference will be made in the sequel. The axis of Grand Traverse Bay trends meridionally, as that of Little Traverse Bay trends transmeridionally. There are also some unimportant streams in the southern peninsula whose general direction is cardinal; but even in these, it is interesting to note to how great an extent the general course is made up from a number of inconsiderable reaches conforming to the diagonal system.

If we look toward the upper peninsula, the attention is immediately arrested by the euroboreal trends of Kewenaw Point and Bay, the copper range, the Porcupine Mountains and Ile Royale. The general watershed of the upper peninsula exemplifies the law in a beautiful manner. Beginning at Pt. Detour it pursues a west-northwest course 23 miles; it then proceeds N.N.W. 13 miles, then W.N.W. 10 miles, then S.W. 16 miles, then N.W. 43 miles, then S.W. 34 miles, then N.W. 6 miles, then a little E. of N. 6 miles, then S.W. 12 miles, then N.W. 37 miles, thence S.W. by zigzag courses 50 miles to the Wisconsin line. The Menominee, Escanaba and other affluents of Green Bay flow southeast. The same is true of the upper waters of the Monistique and all its tributaries, while the main river flows southwest. The Montreal, Presqu'Ile, Ontonagon, Flint-steel and all the streams of Kewenaw Point, have their

axes along the euronotal. The Sturgeon River rises near Lake Michigan, flows N.W. 11 miles, then S.W. 8 miles (meeting a tributary from the S.W.), then N.W. 7 miles, then N.E. 25 miles, into Portage Lake, thence S.E. 6 miles through Portage River into Kewenaw Bay—thence finally N.E. through Kewenaw Bay into Lake Superior.

These examples may serve to illustrate sufficiently the law enunciated. But its application is not confined to Michigan. The Maumee River of Ohio, with its tributaries, is a striking reproduction of the Saginaw and its affluents. The Maumee, flowing east-northeast, is fed by the Auglaize and St. Mary's from the southeast, the St. Joseph from the northeast and the Tiffin from the northwest—the last named, in its higher reaches, flowing from Hillsdale County, Michigan, first southeast and then southwest. In Wisconsin, the euroboreal basin of Green Bay is prolonged through the Fox River into Lake Winnebago. The euroboreal trend is seen in the shore-lines about Chegowawegon Bay, the Apostle Islands and the western extremity of Lake Superior. Even the upper Mississippi, whose general course is meridional, divides itself into a succession of reaches conforming strangely to the law of diagonism; while, on the other hand, the river and gulf of St. Lawrence are a further indication that something in the course of events which have fashioned the actual surface, has exerted a greater energy in the direction of the diagonals than in the direction of the cardinal points of the compass.

The causes of these curious phenomena are not difficult to discover. Geological structure will, indeed, be found closely connected with them. The watershed of the Monistique Peninsula follows, in its *general* trend, the strike of the Lower Silurian strata; as the southeastern watershed of the lower peninsula follows nearly the belt of outcrop of the Marshall sandstone. So too, the axes of Lake Michigan and its appendages, Georgian Bay, Kewenaw Point and Lake Ontario, conform to the geological trends. But another force has evidently been operative, for the trends of the physical features of the country have often been deflected from the lines of geological strike. Saginaw Bay trends at right angles to geological strike; and so does Little Traverse Bay. The central watershed and most of the river-valleys sustain imperfect relations to rocky structures. As it is now generally admitted that the whole region under consideration has been extensively glaciated, it seems reasonable to presume that this glaciation is the general cause which has deflected the topographical and hydrographical axes from strict relations to the geological strike. As it has been shown by Prof. N. H. Winchell,* that the glacier probably moved toward

* Proceedings Amer. Assoc., Dubuque Meeting, 1872.

the southwest through Lake Erie and the valley of the Maumee; and as we long since reported this as the direction of the principal set of glacial furrows at the west end of Lake Erie,* it seems equally probable, even without collateral evidence, which we have, that the glacier moved in the same direction along Saginaw Bay and the valley thence to Grand Haven; and in a similar direction in the regions about Green Bay. This movement shaped the southeastern and central watersheds of the lower peninsula, and may have impressed its action upon the relief of regions much farther toward the west and northwest. The euronotal trends of river-courses, alternating with euroboreal trends have been determined by the breakage of the drainage across the euroboreally disposed barriers, down slopes whose general descent is euronotal, or across the euronotally-disposed barriers, down slopes whose general descent is euroboreal.

Not to pursue the discussion further, we think the facts will justify the enunciation of the following general proposition: *The actual topogrophical and hydrographical axes of Michigan are the resultant of two forces—a glacial, acting from the northeast, and a stratigraphical, acting along the lines of strike.*

As a corollary, we shall find that where the rocky formations are most consolidated, the resultant lies nearest to the stratigraphical force; and where the rocky formations are little consolidated, the resultant approximates the line of the glacial force.

As a second corollary, physical features determined by causes which have *obliterated* the glacial and stratigraphical trends, do not necessarily express relations to either force. Of this kind are the small streams whose courses over the diluvial beds have been determined by post-glacial erosions, and river-courses, like the St. Clair and Detroit, marked out across lacustrine or other post-glacial deposits which have concealed the surface features due to geological structure or glacial erosion.

Syracuse University, May 26, 1873.

ART. IX.—*Notices of recent Earthquakes;* by Prof. C. G. ROCKWOOD, Jr., Bowdoin College.

Dec. 14 and 15, 1872. Fuller accounts have been received of the earthquake in Oregon and Washington Territory on these dates. (This Journal, III, v, p. 262–3). Shocks occurred at intervals from the evening of Dec. 14 to the evening of Dec. 17. They were felt from Eugene City, Oregon, north into British Columbia, and on both sides of the mountains, i. e.

* Michigan Geolological Report, 1861, p. 128.

over an area of 200 miles square; but were most severe in the neighborhood of Puget Sound. The following is from the "Pacific Tribune," Dec. 21, 1872 (Olympia, W. T.): "Capt. James S. Lawson took a scientific observation of the earthquake on Saturday night last. Its direction was from the south to the north at first; subsequently it changed around to a course from the southwest to the northeast. It was timed with a chronometer watch and the direction noted by a swinging lamp. In an unofficial report to Prof. Davidson, at San Francisco, Capt. Lawson says:

Dec. 14, 1872. Shock occurred precisely at $9^h\ 40\frac{1}{2}^m$ P. M. It commenced with a light movement, gradually increasing for eighteen or twenty seconds. Then came the heavy shock, lasting four or five seconds; then it gradually decreased. In six minutes after the first shock there was another, followed by two others one minute apart. At $10^h\ 12^m\ 40^s$ there was another shock, and after 11 P. M. there were five others.

During the night other shocks were reported (I did not feel them), at 3 and 5 o'clock.

On Sunday evening, at $6^h\ 37\frac{1}{2}^m$ a light shock.

Dec. 16, at $9^h\ 17^m\ 30^s$ A. M., another light shock."

A report from Walla Walla, Jan. 4, 1873, says that light shocks had occurred almost daily up to that time.

Jan. 9, 1873. A letter of March 28th, from Reykjavik, Iceland, reports an eruption of Skaptar Jokull on Jan. 9th, which lasted four or five days and was accompanied by slight earthquakes.

Feb. 26, 1873. A slight earthquake was felt at Beauport, on the St. Lawrence River.

March, 1873. A recent issue of the San Diego (Cal.) Union speaks of a newly discovered volcanic region, about 25 leagues from Moleje, a town on the eastern coast of Lower California. It says: "On the mountain side, within an area of about 200 yards, there are over 20 vent holes, from which smoke is emitted in jets a yard or more above the surface. Earthquakes have been of rather common occurrence in Moleje for several years. At times the shocks were unpleasantly heavy, threatening to overthrow the buildings of the town. Last year twenty distinct shocks were felt on different occasions, but they were light. During 1870 five earthquake shocks were felt at Moleje, which created considerable alarm, shaking the houses to their foundations."

March 12, 1873. A severe shock was felt at Rome, Italy, at 9.05 P. M. Its direction was from southeast to northwest, and it lasted twelve seconds. The vibrations were strong enough to ring bells and to stop the clock in the Astronomical Observatory.

On the same date violent shocks are reported to have occurred at Osaka, Japan, by which the city is said to have been almost destroyed.

March 18, 1873. A shock was felt in the forenoon at Canton, St. Lawrence Co., New York.

March 19, 1873. The city of San Salvador in Central America, was entirely destroyed by an earthquake.

Though slight tremblings had been felt for some days previous, the first heavy shock occurred about 4.30 P. M. on March 4. At this time there were three violent shocks, which were felt throughout the Republic, and by which many houses in the city were cracked and ruined. The people fled to the fields and squares, and many removed to adjacent villages. In this shake no lives were lost, though much property was destroyed. For the next fifteen days the vibrations continued with more or less frequency and often with considerable intensity.

At 2 A. M. of the 19th, two light shocks, followed by a third of terrible severity, completed the destruction of the city. Every town and village within 20 miles suffered more or less, and it was felt throughout all Central America, and far out to sea. Only two buildings were left standing in the city, the Hotal del Pasque and the Government Palace. A fine brick bridge lately built over the river on the road to Soropango was destroyed, and other roads were rendered impassable by immense blocks of stone, thrown down from the heights. In some places crevices a foot wide and of considerable depth were formed in the ground. One of these extended across the Plaza and for several blocks each way, and emitted sulphurous gases and smoke. By the continued shocks over forty bodies were displaced from their niches in the cemetery.

Capt. Kennedy, of H. M. S. Reindeer, who visited San Salvador immediately after the earthquake, speaks as follows of the desolation of the city. "The whole town was down, with the exception of one or two wooden houses. All the churches, including the cathedral, were a heap of ruins; the spire of the latter had been arrested in its fall and remained in a standing position, like the leaning tower of Pisa, but at a much greater angle. One of the bells must have been swung completely round, as it remained mouth up. The U. S. Consulate was a mass of ruins inside, though the outer walls were standing. The palace being built of wood remained standing, except where stone had been used, in which places the sides had fallen, leaving great gaps in the building. There was not one single house left in a habitable condition. The stronger the walls the greater was the ruin, and the streets were one mass of debris."

Up to March 27, about 50 bodies had been taken from the ruins, and 150 wounded persons were cared for by the authori-

nes. The destruction of property was estimated at $12,000,000. Up to April 24, the vibrations still continued and the Government Palace had at last fallen. The neighboring volcano of Izalco was in eruption at the time of the earthquake.

San Salvador was situated on a small stream about 30 miles from the seaport of La Libertad, with which it was connected by rail. It contained about 15,000 inhabitants. This is the eighth time the city has been destroyed by an earthquake in the last 150 years. The last catastrophe occurred on the evening of Easter Sunday, April 16, 1854.

The following description of the crater of San Salvador, on the slope of which the city is built, is given by a party who made the ascent in January last. After describing the ascent the writer says: "Suddenly and without expecting it they found themselves on the edge of an abyss; the impression from the sudden view of it brought everyone to a stand-still, to contemplate the better such a startling spectacle. An immense cavity suddenly yawned before them, about a kilometer wide and 400 yards deep, representing an inverted cone, but lined with an exuberant vegetation and ending in a lake at the bottom. After due consideration of the scene before them, with respect to the probable date of the last eruption, of which no tradition exists, and taking into account the thick stratum of vegetable mould, the size of the trees that grow at the bottom and sides of the crater, and the formation of basalt, it was calculated that this volcano has not been in activity for at least 1000 years.

March 20, 1873. Heavy shocks are reported at Mendoza, Chili.

March 21, 1873. A smart shock was felt about 11.30 P. M. in Montreal.

March 31, 1873. A series of severe shocks were felt about 4 A. M. at Makawao, East Mani, Hawaiian Islands. The vibration was from east to west. A volcanic eruption was feared.

April 12, 1873. In the evening three slight shocks were felt at San Francisco.

April 17, 1873. About 1 A. M., a slight shock was felt at Waterville, Me.

April 21, 1873. A shock was felt at Mission San Gabriel (Cal.), continuing about eight seconds. Its course was north and south.

April 22, 1873. At $10^h\ 13^m\ 31^{sec.}$ P. M., a slight shock was felt at Dayton, Ohio.

April 25, 1873. In the afternoon several shocks were felt in northern New York and on the St. Lawrence.

At Malone and Fort Covington, N. Y., four decided shocks were felt, each lasting about 15 seconds, with intervals of about

an hour between the first and second, and half an hour between the third and last.

At Cornwall, Canada, there were three shocks of considerable violence between 2 and 3 P. M. At Moulinette there was a slight shock as 1 P. M., and a heavier one at $3^h\ 20^m$ P. M.

April 29, 1873. A sharp shock was felt at Doncaster, Eng.

April 30, 1873. In the night a shock was felt at Cornwall and Cateau Landing, and also at Hamilton, Ontario.

About 10.30 P. M., the same night, three shocks were felt at Manor, Tex.

May 3, 1873. About 3 P. M. a shock was felt throughout Gibson and Carroll Counties, Tennessee, and at Cairo, Ill.

For assistance in collecting the above, I am indebted to C. G. Rockwood of Newark, N. J., and to Edward L. Gaul and Jacob P. Thompson of the New York Times.

Brunswick, Me., May 27.

ART. X.—*On a convenient Eye-piece Micrometer for the Spectroscope;* by Prof. O. N. ROOD.

I HAVE recently contrived a very simple eye-piece micrometer for the study of spectra produced by prisms and "gratings," which, while quite inexpensive, is capable of yielding results that are not easily surpassed except by the use of an eye-piece provided with a micrometer screw. A thin semicircular plate of silver is made quite smooth, and rendered black by holding it over the flame of a lamp: it is afterward flowed with a drop of weak spirit-varnish to cause the lampblack to adhere. Crossing the straight edge of this dead-black surface, lines $\frac{1}{4}^{mm}$, etc., are ruled with a dividing engine, and the necessary figures added with the help of a lens. The opaque semi-circular plate is then introduced into the interior of a negative, or preferably in front of a positive eye-piece, so that it is in focus and does not occupy quite half of the field of view. Opposite it, and somewhat nearer the eye, an opening is made in the side of the eye-piece, whereby the lines are brightly illuminated—as a general thing, merely by the diffused light of the room; but if this is quite dark, the small flame of a distant lamp easily accomplishes the same end. This arrangement, it will be seen, furnishes a set of bright lines on an almost perfectly black ground, with the least possible outlay of expense or trouble in manipulation, and the *degree* of their brightness, it will be found, can readily be regulated merely by shading the opening more or less with the hand. The distance of the lines apart should not be too small, as is

often the case in the photographic scales of ordinary spectroscopes, but such as will facilitate the estimation of tenths of a division. Two such eye-pieces have been constructed, and employed by me with much satisfaction in the mapping of a large number of spectra furnished by prisms and gratings, particularly in those cases where the spectral lines were quite faint.

Columbia College, June 4th, 1873.

Art. XI.—Adam Sedgwick.*

Geology has lost her veteran leader! While yet firm in intellect, full of kind and generous feeling, and occupied on the last pages of the latest record of his labors, in the ninth decade of a noble life, Sedgwick has gone to his rest. Under the shadow of this great loss we look back through more than half a century, and behold no more conspicuous figure in the front ranks of advancing geology than the strenuous master workman, the eloquent teacher, the chivalrous advocate of science, who has now finished his task. Severe illness, borne with fortitude, had gradually withdrawn him from scenes once brightened by his ever-welcome presence, but could not tame the high spirit, or cloud the genial sympathies which had won for him, more than for other men, the loving admiration of his fellows in age and followers in study. Rarely has a patriarchal life been crowned with such enduring and affectionate respect.

Born in 1785, of a family long resident in a secluded Yorkshire valley under the shadow of Warnside, the boy early acquired the hardy habits and imbibed the free spirit of the north, and the man retained, till his latest hour, a romantic love of the bold hills and rushing streams amidst which he first became an observer of nature. Every homestead and every family in his native dale of Dent were treasured in his memory, and one of the latest of his minor literary essays was to plead against the

* In connection with this republication of Prof. Phillips' excellent and well merited biographical sketch of Prof. Sedgwick (from "Nature" of Feb. 6,) we would announce that a circular has just been issued with reference to a monument to his memory, which will take the form of a Geological Museum. One of the Secretaries of the London Committee, A. W. Edgell, Esq., has sent us a printed account of the meeting held with reference to the memorial, in the Senate House, Cambridge, on the 25th of March, the Duke of Devonshire, Chancellor of the University, in the chair. The subscription to the fund has been headed by the Chancellor with the sum of £1,000, and others follow on the circular of £200 to £10. The London Committee, consisting of the Duke of Argyll as President, Sir Charles Lyell and many others, "invite the scientific centers across the Atlantic to assist them in their efforts." Prof. Sedgwick was one of the noblest of men, as well as one of the ablest of the foundation-workers in geological science, a man whom all should delight to honor. Subscriptions for "The Sedgwick Memorial Fund" may be sent to Messrs. Robarts, Lubbock & Co.'s, Lombard Street, London.—Eds.

change of the ancient name of a little hamlet situated not far from his birthplace.

Educated under Dawson, at the well-known school of Sedbergh, while Gough and Dalton were residing at Kendal, he proceeded to the great college in Cambridge, to which Whewell, Peacock, and Airy afterward contributed so much renown. Devoted to the Newtonian philosophy, and especially attracted by discoveries then opening in all directions in physical science, he stood in the list as fifth wrangler, a point from which many eminent men have taken a successful spring. He took his degree in 1808, became a fellow in 1809, was ordained in 1817, and for some years occupied himself in the studies and duties of academic life. His attention to geology was speedily awakened, and became by degrees a ruling motive for the long excursions, mostly on horseback, which the state of his health rendered necessary in the vacations.

It was not, however, so much his actual acquirements in geology as the rare energy of his mind, and the habit of large thought and expanding views on natural phenomena, that marked him out as the fittest man in Cambridge to occupy the Woodwardian chair vacated by Hailstone. Special knowledge of rocks and fossils was not so much required as a well-trained and courageous intellect, equal to encounter theoretical difficulties and theological obstacles which then impeded the advance of geology.

The writer well remembers, at an evening *conversazione* at Sir Joseph Banks's, to which, as a satellite of Smith, he was admitted at eighteen years of age, hearing the remark that the new professor of geology at Cambridge promised to master what he was appointed to teach, and was esteemed likely to do so effectually. In the same year Buckland, his friendly rival for forty years, received his appointment at Oxford, where he had previously begun to signalise himself by original researches in paleontology.

At this time the importance of organic remains in geological reasoning, as taught by Smith, was not much felt in Cambridge, where a new-born mathematical power opened out into various lines of physical research,and encouraged a more scientific aspect of mineralogy, and a tendency to consider the phenomena of earth-structure in the light of mechanical philosophy This is very apparent in the early volumes of the Cambridge Philosophical Society, established in 1819, with Sedgwick and Lee for secretaries. Accordingly, the earliest memoirs of Sedgwick, which appear in the Cambridge Transactions for 1820–21, are devoted to unravel the complicated phenomena of the granite, killas, and serpentine in Cornwall and Devon: and to these followed notices of the trapdykes of York-

shire and Durham, 1822, and the stratified and irruptive greenstone of High Teesdale, 1823–24. In his frequent excursions to the north he was much interested in the varying mineral characters and fossils of the magnesian limestone, and the remarkable nonconformity of this rock to the subjacent coal, millstone grit, and mountain limestone; and at length his observations became the basis of that large systematic memoir which is one of the most valuable of the early contributions to the Transactions of the Geological Society. Begun in 1822 and finished in 1828, this essay not only cleared the way to a more exact study of the Coal formation and New Red sandstones of England, but connected them by just inference with the corresponding deposits in North Germany, which he visited for the purpose of comparison in 1829.

To one of these equestrian excursions the writer was indebted for his first introduction to Sedgwick. In the year 1822 I was walking across Durham and North Yorkshire into Westmoreland. It was hot summer-time, and after sketching the High Force, in Teesdale, I was reclining in the shade, reading some easily-carried book. Came riding up, from Middleton, a dark-visaged, conspicuous man, with a miner's boy behind. Opposite me he stopped, and courteously asked if I had looked at the celebrated waterfall which was near; adding that though he had previously visited Teesdale, he had not found an occasion for viewing it; that he would like to stop then and there to do so, but for the boy behind him, "who had him in tow to take him to Cronkley Scar," a high dark hill right ahead, where, he said, "the limestone was turned into lump-sugar."

A few days afterward, on his way to the lakes, he rested for a few hours at Kirkby Lonsdale to converse with Smith, who was engaged on his geological map of the district, and had just discovered some interesting fossils in the laminated strata below Old Red sandstone, on Kirkby Moor, perhaps the earliest observation of shells in what were afterward called the upper Ludlow beds. The two men thus brought together were much different, yet in one respect alike; alike in a certain manly simplicity, and unselfish communication of thought. Eight years after this Adam Sedgwick was President of the Geological Society, and in that capacity presented to William Smith the first Wollaston medal. The writer may be permitted the pleasure of this reminiscence, since from the day when he learned the name of the horseman in Teesdale, till within a few days of his death, he had the happiness of enjoying his intimate friendship.

Sedgwick had acquired fame before Murchison began his great career. After sharing in Peninsular wars, and chasing the fox in Yorkshire, the "old soldier" beame a young geolo-

gist, and for many years worked with admirable devotion to his chief, and carried his banner through Scotland, and Germany, and across the Alps, with the same spirit he had shown when bearing the colors for Wellington at Vimiera.

Important communications on Arran and the North of Scotland, including Caithness (1828) and the Moray Firth, others on Gosau and the eastern Alps (1829–1831), and still later in 1837, a great memoir on the Paleozoic strata of Devonshire and Cornwall, and another on the coeval rocks of Belgium and North Germany, show the labors of these intimate friends combined in the happiest way—the broad generalizations in which the Cambridge professor delighted, well supported by the indefatigable industry of his zealous companion.

The most important work in the the lives of these two eminent men was performed in and around the principality of Wales; Sedgwick, as might be expected, lavishing all his energies in a contest with the disturbed strata, the perplexing dykes, and the cleavage of the lowest and least understood groups of rocks; Murchison choosing the upper deposits exceptionally rich in fossils, and on the whole presenting but little perplexity as to succession and character. One explorer toiling upward from the base, the other descending from the top, they came, after some years of labor (1831 to 1835), in sight of each other, and presented to the British Association meeting in Dublin a general view of the stratified rocks of Wales.

Thus were painfully unfolded the Cambrian and Silurian systems, which speedily became, in a sense, the scientific property of the discoverers, and were supposed to be firmly separated by natural and unmistakeable boundaries. They were, however, not really traced to their junction, though Murchison stated that he had found many distinct passages from the lowest member of the Silurian system into the underlying slaty rocks named by Prof. Sedgwick the "Upper Cambrian," while Sedgwick admitted that his Upper Cambrian, occupying the Berwyns, was connected with the Llandeilo flags of the Silurian system, and thence expanded through a considerable portion of South Wales. (Reports of Brit. Assoc., 1835.) The Bala rocks were disclaimed on a cursory view by Murchison, the Llandeilo beds surrendered without sufficient examination by Sedgwick; thus the two kingdoms overlapped largely; two classifications gradually appeared; the grand volume of Murchison was issued; and then began by degrees a difference of opinion which finally assumed a controversial aspect, always to be deplored between two of the most truly attached and mutually helpful cultivators of geological science in England:—

"Ambo animis, ambo insignes præstantibus armis."

This source of lasting sorrow to both, if it cannot be forgotten, ought to be only remembered with the tenderness of regret.

Familiar as we now are with the rich fauna of the Cambrian and Silurian rocks, and their equivalents in Bohemia and America, it is not difficult to understand, and we may almost feel again the sustained enthusiasm which welcomed the discoveries which seemed to reveal the first state of the sea, and the earliest series of marine life, "primaque ab origine mundi," almost to complete the physical history of the earth. Starting with a general view of the lake mountains of the north of England, and the great dislocations by which they have been separated from the neighboring chains (Geol. Proc., Jan, 1831), Sedgwick won his difficult way through North Wales to a general synopsis of the series of stratified rocks below the Old Red sandstone, and attempted to determine the natural groups and formations (Geol. Proc. May, 1838). Three systems were named in order—Lower Cambrian, Upper Cambrian, Silurian—the working out of which, stream by stream, and hill by hill, worthily tasked the energies of Ramsay and his friends of the National Survey for many useful years, after increasing ill-health had much reduced the field-work of the Professor.

But now he began to labor more earnestly than ever in the enlargement and setting in order of the collections which were under his personal charge. In 1818, these consisted almost wholly of the small series bequeathed by Dr. Woodward; now they have been expanded, by the perpetual attention and generosity of Sedgwick, into one of the grandest collections of well-arranged rocks and fossils in the world. One of the latest acquisitions is the fine cabinet of Yorkshire fossils, purchased by Cambridge as a mark of loving respect for her great teacher in his fast decaying days.

In this work of setting in order a vast collection gathered from various regions and from all classes of deposits, Prof. Sedgwick, with wise liberality, engaged the willing aid of some of his own pupils, and of other powerful hands brought to Cambridge for the purpose. Ansted, Barrett, Seeley, M'Coy, Salter, Morris, have all helped in this good work, and to their diligence and acumen were added the unrivalled skill and patience of Keeping, one of the best "fossilists" in Europe. Those who in this manner have concurred in the labors of their chief, one and all, found in him the kindest of friends, the most considerate of masters—one who never exacted from others, and always gave to his assistants more than the praise and the delicate attention which their services deserved.

The ample volume entitled "British Palæozoic Rocks and Fossils, 1851–5," by Sedgwick and M'Coy, must be consulted for a complete view of the classification finally adopted by

Sedgwick; and further information is expected from the publication of a Synoptic Catalogue, to which Salter gave some of his latest aid.

Never was a man so universally welcome among the members, and especially the junior members of his own university. Wonderful was the enjoyment of a voyage to Ely with a happy crew of his pupils (1850). If one stopped at Upware, the oolite there uplifted became the topic of an amusing and instructive discourse; the great cathedral was visited in a more serious mood; the shores rang with the merriment of the returning boat; and the evening closed with a joyous banquet in the hospitable college rooms.

During his long tenure of a fellowship in Trinity College, Prof. Sedgwick witnessed great changes in the mathematical training, and contributed as much as any man to the present favorable condition of science in Cambridge.

To defend the University against hasty imputations, to maintain a high standard of moral philosophy, and a dignified preference for logical induction to alluring hypothesis, was always in his thoughts. Hence the "Discourse on the Studies of the University of Cambridge," at first an eloquent sermon, grew by prefix and suffix to a volume which he himself likened to a wasp —large in front and large behind, with a very fashionable waist.

Under such feelings he spoke out against the "Vestiges of Creation" with a fervor of argument and declamation which must have astonished the unacknowledged author of that once popular speculation. Nor was he silent when the views of Darwin came to fill the void places of biological theory, against which he not only used a pen of steel but made great use of his heavy hammer.

The vigor—vehemence we may call it—of his pen and tongue, in a matter which touched his sense of justice, morals, or religion, might mislead one who did not thoroughly know his truth and gentleness of heart, to suppose that anger was mixed with his honest indignation—

ου γαρ μειλιχος εσκε . . . εν δαΐ λυγρη

But it was quite otherwise. In a letter addressed to the writer, in reply to some suggestion of the kind, he gave the assurance that he was resolved "no ill blood" should be caused by the discussion which had become inevitable.

He never failed in courtesy to the honest disputant whose arguments he mercilessly "contunded." Taken altogether, Professor Sedgwick was a man of grand proportion, cast in a heroic mould. Pressed in early life through a strict course of study, he found himself stronger by that training than most of his fellow geologists, but never made them feel his superiority. Fa-

miliar with great principles, and tenacious of settled truths, he was ready to welcome and encourage every new idea which appeared to be based on facts truly observed, and not unprepared or unwilling to stand, even if alone, against what he deemed unfair objection or unsubstantial hypothesis.

This is not the place to speak of his private worth, or to indulge in reminiscence of his playful and exuberant fancy, the source of unfailing delight to those who knew him in his happier hours. Unmarried, but surrounded by plenty of cheerful relatives, his last hours of illness were soothed by sedulous affection; his kindly disposition no suffering could conceal; his lively interest in passing events nothing could weaken. Ever

> "Against oppression, fraud, or wrong,
> His voice rose high, his hand waxed strong."

With collected mind, on the verge of the grave, he would express, with undiminished interest, his latest conclusions on his own Cambrian system, purely as a matter of scientific discussion, free from all personal considerations. It will be well if this mode of treatment be reverently followed by those who, while speaking of Protozoic and Paleozoic rocks, know enough to feel how much they have been benefited by the disinterested labors of a long and noble life.

ART. XII. — *Discovery of a new Planet;* by Prof. C. H. F. PETERS. (Communication to one of the Editors, dated Litchfield Observatory of Hamilton College, Clinton, N. Y., May 26, 1873.)

I TAKE pleasure in giving notice of another planet of the asteroid group, discovered night before last. It resembles a star of 11th magnitude, and was observed in the following positions:

1873.	Ham. Coll. m. t.	α (131).	δ (131).
May 24.	$15^h\ 17^m\ 58^s$	$15^h\ 16^m\ 10{\cdot}90^s$	$-21°\ 17'\ 49{\cdot}8''$
" 25.	13 12 57	16 15 14·03	−21 18 1·6

whence its motion in twenty-four hours is concluded to be $-1^m\ 4^s$ in A.R., and $-13''$ in decl.

Not far from the planet, only about a degree south of it, is that splendid, resolvable nebula 80 (Nessier) Scorpii; and four degrees farther north may now be observed the still extremely faint comet of Tempel, of short period, whose position on May 23d I determined

Δ $13^h\ 25^m\ 54^s$ m. t. $\quad \alpha\ c = 16^h\ 29^m\ 18{\cdot}06^s \quad \delta\ c = 16°\ 26'\ 28''{\cdot}0,$

with a motion of about ten minutes per day toward the south.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *New Determination of the Velocity of Light.*—Cornu has repeated, with all the precautions suggested by the recent progress in physical science, the experiment of Fizeau to determine the velocity of light. His researches, which have extended over a period of three years, lead him to conclude that the toothed wheel used in this method, is capable of giving more accurate results than the revolving mirror, employed by Foucault. The principal station, containing the toothed wheel and the mechanism for rotating it, the means of illumination, the telescope, the velocity-register, etc., was at the Ecole Polytechnique. The other station, in which the collimating telescope and the reflector were placed, was at Mont Valerien. The distance between them was carefully measured and found to be 10310 meters, with a probable error of less than ten meters. The wheel was carried upon the arbor of the minute-hand of an improved clock-work. Three of these wheels were made use of, having respectively 104, 116, and 140 teeth. To the clock-work an electric apparatus to register the velocity of rotation was attached, and also the means for regulating its motion, and even reversing its direction. A velocity of 700 to 800 revolutions per second could be thus obtained, which was uniform, and perfectly under control. The registering apparatus consisted of a chronograph, upon the revolving cylinder of which three electro-magnetic pens made their marks; one of these marked seconds, the second marked the rotations of the toothed wheel, and the third, controlled by a key in the hands of the observer, marked the instants of eclipse. The calcium-light was generally employed as the source of illumination, though a simple petroleum lamp was also occasionally used. Over a thousand separate observations were made and registered upon the chronograph; but only the best of these, six hundred and fifty in number, were reduced. These reductions gave the following values in kilometers, for the velocity of light as deduced from the various orders of the occultation:

1st order.	2d order.	3d order.	4th order.	5th order.	6th order.	7th order.
----	302,600	297,300	298,500	298,800	297,500	300,400
----	(17)	(236)	(376)	(480)	(91)	(27)

The numbers in parentheses express the relative value of the corresponding observations; and are obtained by dividing by 10 the product obtained by multiplying the number of observations by $2n-1$ (n being the order of the eclipse) and by 1, 2, 3 or 4, according as the observation was recorded as fair, good, very good, or excellent. The mean result is 298,400 kilometers; multiplying this result by 1·0003, the refractive index of air, 298,500 kilometers is obtained as the velocity of light in a vacuum. This, Cornu believes, is accurate to $\frac{1}{300}$ of its value. It is a close approxima-

tion to the result of Foucault, 298,000 kilometers, and also corresponds very closely to the value obtained from the solar parallax, which has recently been calculated by Leverrier from observations upon Mars and Venus to be 8″·86. Cornu believes that with stations separated from 20 to 30 kilometers, it would be possible by this method to obtain a value accurate to within a thousandth.—*C. R.*, lxxvi, 338, Feb., 1873. G. F. B.

2. *On the Activity of Chlorine in the dark.*—MELSENS has observed that carbon in the form of coke, purified by repeated washings and ignitions in a current of dry chlorine, can absorb nearly its own weight of this gas. If now a current of hydrogen, previously dried over phosphoric oxide, be passed over this chlorinated carbon, even cold and in absolute darkness, notable quantities of hydrochloric acid gas are disengaged. A true combustion of hydrogen in chlorine takes place, the temperature being actually lowered by the return of the chlorine to the gaseous state.—*C. R.*, lxxvi, 92, Jan., 1873. G. F. B.

3. *On the preparation of Chromic Trioxide.*—In the ordinary preparation of chromic trioxide by the action of sulphuric acid upon potassium dichromate, the yield is unsatisfactory, the product is impure, and the process is tedious. DUVILLIER proposes to boil together for ten minutes 100 parts of barium chromate, 100 parts of water, and 140 parts of nitric acid of 40° B. To the red liquid, 200 parts more of water are added, and the whole is boiled ten minutes longer. On cooling, barium nitrate is deposited in crystals; and on concentration to the bulk of the acid employed, all the nitrate but one half per cent crystallizes out on cooling. The excess of nitric acid is then driven off by evaporation, and on cooling the trioxide separates in black mammillated masses. These may be freed from barium by re-solution, and precipitation with a little dilute sulphuric acid.—*Ann. Chim. Phys.*, IV, xxviii, 260, Feb., 1873. G. F. B.

4. *On the Synthesis of Propionic acid.*—The alkali-hydrates absorb carbonous oxide with the formation of formic acid; may not its absorption by the alkali-alcoholates give rise to the higher members of the fatty acid series? thus:

$$C_nH_{2n+1}O\,Na + CO = \left\{ \begin{matrix} C_nH_{2n+1} \\ CO\,ONa \end{matrix} \right.$$

BERTHELOT has re-investigated the action under these circumstances. To exclude every trace of moisture, barium alcoholate was dissolved in alcohol and exposed to the carbonous oxide gas. It slowly absorbed it and produced barium ethyl-formate, a compound soluble in absolute alcohol, decomposed by water, and isomeric with propionic acid, a trace of which is simultaneously formed.—*Bull. Soc. Ch.*, II, xix, 160, Feb., 1873. G. F. B.

5. *On the formation and decomposition of Ketones.*—The splitting, by fusion with potassium hydrate, of benzophenonparadisulphonic acid into paraoxybenzoic acid and phenol, and of benzophenone into benzoic acid and benzol, led STAEDEL to apply this method to anthrachinone. The result was the production of

an acid isomeric or identical with the benzoylbenzoic acid of Zincke. From these experiments, Staedel concludes that the formation of ketones by heating the calcium salt of an organic acid, takes place in two stages. In the first, O ca* from one molecule unites with H from the other, the two residues thus produced uniting together thus:

$$\begin{matrix} C_6H_4 . \overset{\displaystyle H}{\underset{\displaystyle O\ ca}{CO\ O\ ca}} \\ C_6H_5 . CO \end{matrix} = \begin{matrix} C_6H_4 . CO\ O\ ca \\ \vdots \\ C_6H_5 . CO \end{matrix} + HO\ ca.$$

In the second the calcium hydrate reacts upon this calcium salt, producing the ketone and calcium carbonate, thus:

$$\begin{matrix} C_6H_4 . CO\ O\ ca \\ \vdots \\ C_6H_5 . CO \end{matrix} + HOca = \begin{matrix} C_6H_5 \\ \vdots \\ C_6H_5 \text{---} CO \end{matrix} + CaCO_3.$$

In the case of anthrachinone, a repetition of the first stage is observed, however, the second O ca uniting with another H, thus:

$$\begin{matrix} \overset{\displaystyle H}{\underset{\displaystyle C_6H_4CO}{\overset{\displaystyle \quad + \quad}{\underset{\displaystyle O\ ca}{ca\ O\ CO}}}} \\ \qquad\qquad H \end{matrix} C_6H_4 = C_6H_4 \left\{ \begin{matrix} CO \\ CO \end{matrix} \right\} C_6H_4.$$

If this view of the formation of ketones be correct, the ketone of a substituted benzoic acid must be unsymmetrically constituted; the ketone obtained by the dry distillation of calcium salicylate, for example, yielding, on fusion with potassium hydrate, a mixture, besides phenol, of oxybenzoic and salicylic acids. The author is engaged in preparing a dioxybenzophenone synthetically, with which to test this question, by comparing it with the ketone produced as above.—*Ber. Berl. Chem. Ges.*, vi, 178, March, 1873.

G. F. B.

6. *On the Synthesis of Right and Left Tartaric acid.*—Chemical synthesis has hitherto failed to produce any cases of physical isomerism. Indeed, in the case of many bodies having rotatory power, and thus physically different while chemically identical, it has been supposed that the rotatory power came from the living organism which originated these bodies, being given by a process science could not imitate. JUNGFLEISCH, however, has succeeded in producing, by purely synthetic methods, tartaric acid having rotatory power. Pasteur has distinguished four kinds of tartaric acid: (1) the natural or dextrotartaric acid, hemihedral and rotating a polarized ray to the right; (2) lævo-tartaric acid, also hemihedral, and rotating to the left; (3) racemic acid, optically neutral, and capable of splitting into (1) and (2); and (4) inactive tartaric acid, not hemihedral and not rotating, but not capable of splitting up as above. Having succeeded in transforming the inactive acid into racemic, which, on splitting, gave the right and left acids, Jungfleisch attempted the complete synthesis. Starting with ethylene—which, through acetylene, may readily be

* Kekulé uses ca to represent ½ Ca.

formed from its elements—this was transformed into ethylene dibromide; and this, by Maxwell Simpson's method, into ethylene dicyanide. This oxidized by nitric acid yielded succinic acid. Treated with bromine, bibromosuccinic acid was obtained, and this by Kekulé's method was converted into tartaric acid. 3800 grams of ethylene bromide gave 300 of cyanide, about the same quantity of succinic acid, and nearly 70 grams of pure calcium tartrate. This tartrate was a mixture of calcium racemate and inactive tartrate, as Pasteur had shown to be the case with that made from the commercial succinic acid. The inactive acid was then converted into racemic acid, and this, by Pasteur's process, was changed into potassio-sodium tartrate. Two sorts of crystals were produced; one, hemihedral to the left, identical with the lævo-tartrate; the other hemihedral to the right, identical with the dextro-acid, and yielding a dextro-rotatory solution whose specific rotatory power was 5° 3′ against 6° 4′ for the perfectly pure natural salt.—*C. R.*, lxxvi, 286, Feb., 1873. G. F. B.

7. *On the Synthesis of Tyrosin.*—LADENBURG has shown that ethylenoxyparamidobenzoic acid—prepared by heating to 50° C equal molecules of ethylene oxide and paramidobenzoic acid in a sealed tube—is not identical, but only isomeric with tyrosin.—*Ber. Berl. Chem. Ges.*, vi, 129, Feb., 1873. G. F. B.

8. *A Treatise on Electricity and Magnetism;* by JAMES CLERK MAXWELL, M.A., LL.D., etc. Professor of Experimental Physics in the University of Cambridge (England). Two vols. 8vo, pp. 425 and 444. Oxford, Clarendon Press; London and New York, Macmillan & Co. Price $12.00.—This treatise is an analytic description of the phenomena of Electricity and Magnetism. It takes up the whole subject in a methodical manner and indicates how each part of it is brought within the reach of methods of verification by actual measurement. It is designed to supply what the various treatises which describe electrical and magnetic phenomena in a popular way do not give to those who are, by reason of the important applications of electro-magnetism to telegraphy and the like, compelled to consider the quantities to be measured in a mathematical form. The author states that he commenced the study of electricity by first reading attentively *Faraday's Experimental Researches on Electricity*, before reading any of the existing mathematical discussions of the subject, aware that there was a supposed difference between Faraday's way of conceiving of phenomena and that of the mathematicians, so that neither he nor they were satisfied with each others language. This difference our author finds to be seeming and not real. Faraday's method of conceiving the phenomena was also a mathematical one, though not expressed in formulæ. He adds: "When I had translated what I considered Faraday's idea into a mathematical form, I found that in general the results of the two methods coincided, so that the same phenomena were accounted for and the same laws of action deduced by both methods, but that Faraday's methods resembled those in which we begin with

the whole and arrive at the parts by analysis, while the ordinary mathematical methods were founded on the principle of beginning with the parts and ending up the whole by synthesis. I also found that several of the most fertile methods of research discovered by the mathematicians could be expressed much better in terms of ideas derived from Faraday than in their original form."

In looking over Prof. Maxwell's book we are impressed with the fact that the demand of late for exact knowledge on the part of practical electricians has greatly advanced this department of knowledge and has carried its proficients beyond the range of ordinary scientific students. Only those well up in mathematical knowledge and the use of the processes of analysis can read Prof. Maxwell's treatise. B. S.

9. *Wöhler's Outlines of Organic Chemistry;* by Dr. R. FITTIG. Translated, with additions, by Dr. IRA REMSEN, Professor of Chemistry and Physics in Williams College, Mass. 530 pp. 8vo. Philadelphia, 1873. (Henry C. Lea.)—This compact treatise is an excellent hand-book of Organic Chemistry for the student attending lectures or engaged in laboratory work. About 40 pages are occupied in introductory and general matters; then, beginning with marsh gas, the remainder of the volume contains brief descriptions of the hydrocarbons, alcohols, acids, aldehydes, ketones, &c., whose chemical structure has been ascertained, together with those substances which are important in Medicine, Physiology and the Arts. Probably no published book contains so complete a list of the numerous isomeres, whose recent discovery is one of the most striking evidences of the fruitfulness of the ideas which underlie the "Modern Chemistry."

The notation is given in the simplest graphic form, and the relations of the various classes of bodies and of individual substances to each other are easily traced. Dr. Remsen has discharged his duty as translator in a thoroughly acceptable manner.

S. W. J.

II. GEOLOGY AND MINERALOGY.

1. *On the Klamath River Mines; remarkable gravel deposits of the Lower Klamath—a sketch of their Geology;* by A. W. CHASE.—The upper portions of the Klamath river and its tributaries, the Trinity, Salmon and other streams, have long been the scene of active placer and hydraulic mining. But little attention has, however, been given, up to this time, to the remarkable deposits on the main river toward its mouth. This is partly owing to the fact that about the time prospecting had commenced in the section, the silver excitement drew off the restless spirits who perform the pioneer work in all mineral development. Being off the regular routes of travel and not easily accessible from stage or steamer lines, and in addition being the home of Indians alone, few white inhabitants being found for many miles above its mouth, the gravel deposits of the lower river have remained unnoticed—almost untouched—while others in different portions of the State

were being actively worked, and, as a rule, paying the owners better than any other class of gold mining. To the geologist, however, and the practical miner, these deposits offer a field of interest and profit second only to the famous blue gravel mines, which they resemble in many particulars.

It is probable, however, that they are not the deposition of an ancient river, but that of the present stream under different conditions from those now existing. In order to present a theory of their formation, it is necessary to take into account the character of the river and the underlying rock strata through which it has cut its way. The Klamath drains an immense extent of mountainous country, through which passes the great auriferous belt of California, as evidenced by the rich quartz leads and placer mines on the tributaries. Being a swift and deep stream, great quantities of water-worn gravel are swept down by the resistless floods of winter. These form at present as gravel bars, increasing in extent toward the mouth, all more or less auriferous, and their presence can be easily accounted for. A remarkable distinction should be noticed here. Any attentive observer who has watched the action of the surf rolling up pebbles on a sea or lake beach has noticed that the shape assumed by the stones is that of a sphere, the grinding action being equal on all sides. On the contrary, the gravel worn by river action alone will be flattened or oblong in shape, the continuous flow of the river being in one direction and the gravel wearing more rapidly on one side than the other. Hence, when deposits of water-worn gravel, flattened rather than rounded in shape, are found four and five hundred feet above the present level of the stream, one must seek some other solution than that of present action, as no flood, however great, could have piled up these masses of gravel.

This solution can be found on observation of the rock strata forming the river bed and cropping out on the sides. Commencing at the mouth of the stream, one will notice that this stratum consists of ledges of metamorphic sandstone of an exceedingly hard nature, and that it continues to appear for about fifteen or twenty miles as you ascend. In this section, although the gravel bars formed by the present action are frequent, yet no old deposits are found on the banks. At the end of this stretch of fifteen or twenty miles, the character of the rock suddenly changes. A soft micaceous slate now appears dipping at an angle of 15 degrees to 45 degrees against the stream. This gradually rises as you proceed up the river, until at a distance of thirty miles from the mouth it is seen cropping out many feet above the level of the stream. It is in this portion that the great banks of gravel appear on the sides. On investigation of the causes that formed them, one is instantly struck by the fact that they are invariably found above and below a rapid or fall in the river, and that the bed rock at these rapids is a hard talcose slate or serpentine. This fact can be seen on the sides of the river also, and suggests a theory. It is that the river, which now has a fall of 234 feet in the thirty

miles from the deposits to the mouth, was at one time many hundreds of feet above its present level. Wearing away the soft slate, it has met with an obstacle in the dykes of serpentine forming the lofty waterfalls. Here the gravel was deposited, in the still reach above and the eddies below. Gradually the action of the water has worn away the serpentine, until what was perhaps a thousand years ago a great fall, is now a rapid, over which canoes can be taken. That this is the case, evidence in point is offered by a celebrated and once dreaded rapid, called the Mareep, about 34 miles from the mouth. Within the memory of the oldest white inhabitant of the river, the Indians were accustomed to land at the foot of this rapid and haul their canoes over the bank, as the fall was too great to stem going up, and dangerous to run going down. At the present time no difficulty is experienced in poling up or in paddling down. As the river cut its way down, it also changed its course, perhaps many times, so that the deposits are now on one side, then on the other, of the present bed. Opposite the gravel beds is usually a bare mountain of rock, rising abruptly from the stream.

It is said by one of the old prospectors that, starting at the point where the sandstone formation commences, the gravel can be traced through the mountains, good prospects being found even on the summits, and that it finally ends in the immense cliff known as the Gold Bluff, 25 miles below the present mouth of the Klamath. The spot, the scene of one of the early excitements, is at the present time the theater of active beach-mining operations.

The sea having for ages performed the part of an hydraulic mining pipe, has washed down the gravel bluff and separated the black sand, the gold now being gathered from it when the heavy gales of winter throw it up on the shore. However, this assertion in regard to the continuation of the gravel through the mountains, the writer is not prepared to affirm from personal observation.

Of the deposits on the river one will serve as a sample. This is located about thirty miles from the mouth, and the cut into the hill is 384 feet above the stream and some 500 yards away. The surface bank exposed is about 100 feet, and shows alternate strata of gravel and sand. The bed rock is the same soft slate seen along the river, and is worn into pot-holes and grooves by the old eddies. Above this is a stratum of blue gravel (so-called), decomposed talcose slate, in reality, most probably, the wearings of the dykes before referred to. The stratum is from five to sixteen feet in thickness, and is of course the richest. Above it a reddish or yellow river gravel mixed with sand, and an occasional streak of oxide of iron forming a soft cement.

This entire bank of gravel, as prospected by washing out pansfull from each layer, showed gold at the bottom of each pan, or what is called a color. In the stratum of blue gravel the gold was rather coarse and the pieces flat or oblong in shape, averaging something like two or three cents to the pan. This claim is

now in successful operation and will doubtless repay its owners handsomely for the labor expended on it, as they have an abundance of water and a great fall for tailings.

Were, however, the more improved methods in use in Grass Valley and elsewhere, to replace the rude manner in which this and other of these deposits have been and are now being worked, it is believed that their product would soon attract great attention, as the gold is remarkably pure in character. The climate in the vicinity of the mines is very different from the coast, being hot in summer, with long, rainy winters, but no snow. Peaches, melons and tomatoes will ripen and arrive at great perfection, which they will not do on the coast line.

The gravelly soil seems to be especially adapted to the grape, which grows thrifty and ripens early.

In the vicinity of these deposits are also found the groves of cedar, sugar pine and redwood, which, in time, when mills are erected, will furnish abundance of lumber for mining purposes. Now that the new mineral law allows acquisition of titles to mining property, it is to be hoped that these deposits will receive more attention from our miners and prospectors than they have hitherto done, and that they may add another element to the rapidly increasing mineral wealth of our State.

2. *The Great Basin.*—Dr. JAMES BLAKE, after an investigation of the region of the Great Basin, states (Proc. Cal. Acad. Sci., iv, 276) that the "divide" between it and the Columbia River Valley, near the meridian 118°, is in latitude 41° 33′ N.; and has a height of 400 feet above the level of the Humboldt Valley, 1,000 feet above the lowest part of the sink of that river, and 600 feet above Queen's River Valley, and also the level of the Great Salt Lake basin. Dr. Blake observes that this may not be the lowest "divide." Leading up to the "divide" from the south there is a broad valley, rising 600 feet in 24 miles; and to the north of it there are two broad valleys separated by a low spur of granite having a basaltic axis. This paper concludes with the following paragraph:

"As already stated, the height of the divide above the level of Queen's River Valley is about six hundred feet, but I am of opinion that other outlets must exist, which allowed the waters of the basin to attain a still lower level, before their disappearance solely by evaporation began. There must, however, have been a large body of water left to disappear by evaporation, as the concretionary deposits, to which I last year called the attention of the Academy, are found at an elevation of two hundred feet above the level of the valley, and they could only have been deposited as the water became concentrated by evaporation. I am of opinion that Queen's River Valley, and a large extent of country to the south and west of it, formed part of a secondary basin, in which water to the depth of three or four hundred feet must have disappeared by evaporation. Over the whole of the area of this secondary basin, as far as I have visited it, unmistakable evidences are seen of the gradual evaporation of a large body of water. Not only

are the rocks and boulders surrounded by a thick coating of concretionary matter, but every solid body that was beneath the surface of the water seems to have afforded a nucleus for its deposition. Large numbers of *Anadonta* shells are found on the surface of the ground, entirely encased in this concretionary substance to the thickness of two or three inches. I propose, however, in a subsequent paper, to describe more fully the structure and composition of these deposits. The eastern edge of this secondary basin is formed by the Santa Rosa mountains. On the north is the high land between the Vicksburg and Santa Rosa ranges, and the low divide between Divide and Puebla Valleys. Directly south of the Bottle Creek range the basin is separated from the valley of the Humboldt by a low range of hills about fifteen miles north of the latter river. As to its extent farther to the westward, I have no data. It certainly includes the Black Rock Desert, and I think a considerable extent of country still more to the south and west."

3. "*Lignitic Formation*" *of the Rocky Mountains.*—The second part of Dr. Hayden's Report for 1872 commences with details of explorations connected with the Lignitic formations of the Rocky Mountains by L. Lesquereux, and is followed by an enumeration, with descriptions, of the fossil plants from the same formation and from the Cretaceous of Kansas.

As stated in the letter serving as an introduction to Prof. Lesquereux's report, the arrangement of the paper conforms to the directions given by Dr. Hayden for the author's exploration, namely, to follow from the Rocky Mountains in New Mexico, northward along the base of the Rocky Mountains to Cheyenne and then along the Union Pacific Railroad to Evanston. It first gives the details of the geological distribution of the strata and their kinds, in the localities which were examined. It then compares the geological and paleontological data which have been recorded and discusses at length the age of the Lignitic beds, refering the whole to the Eocene. A second part considers the Lignitic beds with reference to the mode of formation of the combustible material; then treats of the extent of the areas over which it is distributed, and the thickness of the coal beds; the value of the lignite as a combustible, the amount of material available for the present demand and reserved for the future, etc.

The last part of the report, which is at least one half of the whole, is made up of an enumeration and description of the species of fossil plants, from good specimens mostly obtained by the author in his explorations. It is a valuable contribution to our vegetable paleontology, adding to our Tertiary flora one hundred and thirty species, of which sixty-one are considered as new. The Cretaceous flora, too, though explored only at two localities in Kansas, is also increased by a comparatively large number of new species.

A number of facts and also some discussions interesting to science may be selected from this report for future publication.

4. *The Eozoon Canadense, and related Paleozoic species;* by Dr. J. W. Dawson. (From Dr. Dawson's Annual Address before

the Natural History Society of Montreal, May, 1872, published in the Canadian Naturalist, vol. vii, No. 1, p. 1.)—There remains one point still before leaving this subject. It is the gap between the fauna of the Primordial and that of the Laurentian—the latter still represented only by that Titan of foraminifers, *Eozöon Canadense*. Barrande refers to this gap in his memoir above mentioned; and I had hoped ere this time to have done something to bridge it over. I may here state in anticipation of the results of researches still incomplete, (1) That in rocks of Huronian age in Bavaria, and probably also in Ontario, Eozoon has been found. (2) In the Middle and Upper Cambrian we know as yet few limestones likely to contain such a fossil, but we have in Labrador species of *Archæocyathus*, one of which I have ascertained to be a calcareous chambered organism of the nature of a foraminifer; though there seems little doubt that others are, as Mr. Billings has shown, allied to sponges. (3) In the Cambro-Silurian, in the limestones of the Trenton group, animals of the type of Eozoon return in full force. The concentrically laminated fossils which sometimes form large masses in these limestones, and which are known as *Stromatopora*, are mostly of this nature, though it is true that fossils of the nature of corals have been included with them. In the Silurian proper, we have the similar, if not identical forms known as *Cœnostroma*, and which according to Lindstrom form masses in the shales and limestones of Gothland a yard or more in diameter. In all these fossils the skeleton consists of a series of calcareous layers connected with each other by pillars or wall-like processes. The layers are perforated with minute orifices, which are, however, less delicate and regular than in Eozoon, and have in the thickened parts of the walls radiating tubes of the nature of the canals of Eozoon. (4) On a still higher horizon, that of the Devonian, these organisms abound, so that certain limestones of this age in Michigan contain, according to Winchell, masses sometimes twelve feet in length, and in one place constitute a bed of limestone twenty-five feet in thickness. A beautiful collection of these Devonian forms, recently shown to me by Mr. Rominger, of the State Survey of Michigan, who has worked out these fossils with great care, fully confirms their foraminiferal affinities, aud also shows that in some respects these Devonian forms are intermediate between the Eozoon of the Laurentian and the *Parkeria* and *Loftusia* of the Greensand and Eocene. We thus learn that these gigantic representatives of one of the lowest forms of animal life have extended from the Laurentian, through the Huronian, Cambrian and following formations, down nearly to the close of the Paleozoic. I have no doubt that when these successive forms are studied more minutely, they will show, like the Trilobites, indications rather of successive creations than of evolution, though in creatures of so low organization the differences must be less marked. The point I now wish to insist on is their continuance from the Laurentian down to a comparatively modern geological period.

5. *Elephas Americana in Mexico.*—F. R. DIFFENDERFER, of Lancaster, Pa., reports to one of the editors, that in May, 1870, he opened, in Chihuahua, Mexico, a bed containing a large number of teeth of the extinct elephant. The teeth formed with coarse gravel a compact conglomerate. It is probable that search in the region would bring to light the tusks and other parts of skeletons of the elephant.

6. *Report of the Geological Survey of Ohio;* officers of the Survey, J. S. NEWBERRY, Chief Geologist; EDWARD ORTON and E. B. ANDREWS, Assistant Geologists; T. G. WORMLEY, Chemist, F. B. MEEK, Paleontologist. Volume I, Geology and Paleontology; Part I, *Geology.* 680 pp. 8vo. 1873. Columbus, Ohio. Published by authority of the Legislature of Ohio.—The publication of the first volume of this report has already been briefly announced. The volume opens with a historical sketch of the previous geological survey of the State under W. W. Mather, entered upon in 1837, and by the legislative action and other matters of general interest connected with the survey just completed. Dr. Newberry, after a chapter on the topography of the State, treats in a popular way of the general geological relations of the rocks of the State to those of the other States, in order to prepare the unscientific reader to appreciate the scientific facts presented beyond. He then enters upon the general subject of the geological structure of Ohio, giving a clear exposition of the facts both as regards the system of rocks and the progress of life. The structure and age of the Cincinnati anticlinal—a region nearly parallel with the Alleghanies, made up at surface about Cincinnati and elsewhere of Lower Silurian rocks, and ranging southeast from Lake Erie into Tennessee—are treated at considerable length, and the conclusion established that this geanticlinal or upward bending of the crust took place after the last period of the Lower Silurian—the Cincinnati period, as it is now called (Hudson River period in New York geology). The extension of this geanticlinal into Tennessee was long since made known by Prof. Safford. Dr. Newberry remarks that the course of it "is marked by no conspicuous topographical features, but throughout its whole length the rocks are raised in a distinct arch, from which they dip away, on one side, under the Alleghany Coal field; on the other, beneath the Coal basin of Indiana and Illinois." To a great extent, the rocks of the central portions of the arch have been removed by denudation—so that these portions are now basins surrounded by elevated margins composed of later and more resistant strata once deposited in the sea around them when they stood as islands. These strata very generally thin out toward the arch, proving thus their subsequent origin. Besides presenting his own observations on the subject, Dr. Newberry appeals to facts obtained by Prof. Orton in his careful investigations of the Cincinnati region. Dr. Newberry describes also the special geology of Cuyahoga County, treating of its rocks, fossils, lake ridges or shore terraces, drift, economical productions, including coal, etc.; and adds a briefer account of the geology of Summit County.

The geological structure, products, and general relations of the second geological district are discussed at length, and with much that is new and important, by Prof. E. B. Andrews. It includes Gallia, Meigs, Allen, Morgan and part of Muskingum Counties, and embraces a large part of the Coal formation in Ohio. Prof. Andrews closes with "some conclusions theoretical and practical" on the structure of the district and especially on its Coal measures, coal beds and coal. Were it within the compass of this Journal we should like to introduce here the whole chapter. He shows that the Coal marshes were but little above the sea level, and were therefore flooded with salt water at slight changes of level. He states that the occurrence of broken down trees of *Sigillaria*, *Lepidodendron*, etc., sometimes show the effect of the incoming sea attending a subsidence; and observes that "he once traced the trunk of a *Sigillaria*, in the roof of the Pomeroy seam of coal, for over forty feet;" and also that thousands of the trunks of what Mr. Lesquereux takes to be *Pecopteris arborescens* are found in the slates over the same coal lying in horizontal burial as they were bent or broken down by the waters which brought in the sediments that cover them. As a general thing, the subsidence was so regular that two beds of coal, each formed at the water level, are almost perfectly parallel. The Nelsonville bed in Ohio, for example, is about 420 feet below the Pomeroy bed (the equivalent of the Wheeling and Pittsburgh bed) through many counties in the State; and the same is true of the other well-defined beds. Prof. Andrews says that he has not found any instance in which two distinct beds of coal coalesced in one.

Prof. Edward Orton had charge of the third geological district, including Hamilton, Clermont, Warren and Butler Counties. He gives a full and able account of the region with regard to all its ranges of formations from the Lower Silurian to the Drift, and the soil and its productions at surface. The Cincinnati group is described at length, and the various facts bearing on the fact and era of the Cincinnati uplift are presented in detail, and illustrated by a map.

The geology of Ashtabula, Trumbull, Lake and Geauga Counties is reported on in the following pages of the Report by M. C. Read; of Williams, Fulton and Lucas Counties, and West Sister Island, and the surface geology of the Maumee Valley by G. K. Gilbert; and the geology of Sandusky, Seneca, Wyandot and Marion Counties, by N. H. Winchell. In each the region under investigation appears to have been well studied. The study of the drift and terraces of Maumee Valley by G. K. Gilbert, has led Prof. Gilbert to important results—as the readers of this Journal have already gathered from his pages in the first volume of the present series (1871).

Many of the pages of the several reports owe much of their value to analyses and other results of chemical investigations by the chemist of the survey, Mr. T. G. Wormley, some of whose

determinations with respect to the condition of the sulphur in the Ohio mineral coal have already appeared in this Journal.*

The State has been ably served by its geologists both in the work performed and in the preparation of the Reports presenting its results. The geology of the several districts are separately illustrated by colored geological maps; and the style of the volume is well adapted to give intelligible ideas of the geology and mineral productions of the State to its people. This volume is soon to be followed by another on the Paleontology, by Mr. Meek and Prof. Newberry, which will contain, besides descriptions, numerous excellent plates of fossil plants, shells, crinoids, etc.

7. *The Coal-Regions of America:* their Topography, Geology, and Development, with a colored geological map of Pennsylvania, a railroad map of all the coal-regions, and numerous other maps and illustrations; by JAMES MACFARLANE, A.M. 689 pp. 8vo. New York, 1873. (D. Appleton & Co.)—This volume is a very important contribution to economical geology, by one who has been for sixteen years employed in a large coal business in Pennsylvania. The author has collected with great assiduity the facts respecting the character, structure, distribution, working, economical value, and other points connected with the mineral coal and the coal-regions of the continent. Although a scientific treatise on the Coal formations was not his object, he has brought in much information on the stratification and geological relations of the Coal-measures and their coal beds. The coal-region and products of Nova Scotia are described equally with those of the United States, and those of Cretaceous or Tertiary age in the Rocky Mountains, as well as the true Carboniferous. The geological map of Pennsylvania is by J. Peter Lesley, one of the best of American geologists, who has labored much among the rocks of the State, and especially its coal strata. This and the other maps and illustrations are excellent.

8. *Geological Map of the United States*, compiled for the 9th Census, by C. H. HITCHCOCK and W. P. BLAKE. (J. Bien, New York, lithog.)—The need of a geological map of the United States has been long and urgently felt by all students of the science. The admirable chart of Canada, which, through the liberality of the Canadian government, is made to embrace the northern States to Virginia, and to extend west to the 100th meridian, has supplied the place in part of such a chart. Yet its price—though small considering the size, the amount of detail, and its artistic perfection—is in the way of its general use.† The map now issued by Professors Hitchcock and Blake is a small one (34×22 in.), with no geological details beyond an indication in colors of the grander areas—namely, the Eozoic, with which all the metamorphic areas are united under one color; the Silurian—the Devonian and Subcarboniferous—the Carboniferous and Permian—the Triassic and Jurassic—the Tertiary—the Alluvium—

* Third Series, i, 216.

† Its size is 8 feet by 3½, and it is sold by Dawson Brothers, Montreal, for $18 in sheets, and $24 on cloth in portfolio.

the Volcanic. Even these subdivisions are enough to make a chart of the kind valuable to the general reader.

It is a little puzzling to us to explain why such a chart should have been compiled for "the 9th Census." There is nothing in or on it to indicate that it was intended to illustrate the geographical distribution of mineral products of economical importance. The 9th Census Reports claim to represent the known condition of the country in the year 1870, and this they do with great fullness both in the text and the various excellent maps issued by General F. A. Walker. A geological chart fit to be associated with such work, or to be a part of the publications relating to the 9th Census, should present to the people an exact exhibition of the present knowledge with regard to the geology of the United States, or if not for all its formations, at least for all its varied mineral materials; the agriculturist would say for all its formations with their fullest details; for only on such a map could the particular rock underlying the soil of a region be indicated. At a time when other nations, and Canada among them, are issuing national geological charts that are most admirable productions both of art and science, it is not a little discreditable to the United States for the government to publish so meagre a production. A general U. S. geological chart ought to be published by the General Government, and it should combine all that is contained in the maps that have been made in the course of the various State surveys, and be issued in the best possible style. It would be a great thing for the nation's industry as well as its science if the work could be soon begun, and the best of American art and science be engaged upon it.

The lithographer has done his part on the 9th Census map badly. The glaring colors are selected without taste, and are so unskillfully put on that those of adjoining areas often overlap some miles, and sometimes to the obliteration of a narrow intermediate area that was in the original copy. As one example, the Connecticut River Red Sandstone formation, besides being narrowed in places, is in this way stopped off at Northampton, the remaining 25 miles to the north, which the engraving faintly indicates, being buried beneath the overlapped colors of the areas adjoining. Such careless work does not appear on the Canada geological chart, or those published abroad.

There are a number of improvements—improvements in our view—that may be made in the map in preparing it for another issue. Some of these are: Not to put the carmine color of the Eozoic over all the metamorphic areas of the country whether Eozoic or not, that thus positive knowledge may be kept apart from the doubtful; to take the Sierra Nevada, and some other areas on the Pacific slope, out of the Eozoic carmine, and substitute the color of the Triassic and Jurassic; to leave the metamorphic areas of uncertain age in white, as an acknowledgement of doubt or ignorance; to omit the bands of Lower Silurian around the metamorphic areas of the Rocky Mountains, except so far as specially observed facts

have shown that they exist there; to take away the green color, which means Cretaceous, from the whole of the north side of Long Island, no facts making the region Cretaceous; to put no color over regions "west of the 100th meridian" where "the Paleozoic and Cenozoic systems cannot be subdivided."

9. *Sternbergia.*—Dr. DAWSON states that the pith of the balsam fir (*Abies balsamea*) has the same curious structure of pith that he years since found in Sternbergia, the pith of a Devonian Conifer. It is well seen in young twigs one or two years old, and closely resembles that of *Dadoxylon Materiarium* of the upper Coal formation of Nova Scotia. The structure is in each case an "organic partitioning of the pith by diaphragms of denser cells opposite the nodes."—*Nature*, May 15.

10. *The Story of the Earth and Man;* by J. W. DAWSON, LL.D., F.R.S., F.G.S., Principal and Vice Chancellor of McGill University, Montreal. 404 pp. 12mo. London. (Hodder & Stoughton). —This work is a popular history of the earth, from its genesis to man. The wonderful story is told by an able geologist, and one sound in the faith both of nature and of the Bible. The progress of the continents, mountains and climates, and of life both vegetable and animal from its beginning, is described in a way to interest and instruct. The author brings out the difficulties which geology presents to the theory of natural selection, and takes strong ground against its sufficiency as a means of accounting for the origin of the kingdom of life. Several plates are introduced intended to represent ideal landscapes with their plants and animals, such as it is imagined may have been realities in the successive ages, in order to impress the characteristics of these ages on the minds of the uninitiated. They subserve a good purpose if the reader takes from them only the most general impressions. The known learning and high character and position of Dr. Dawson, as well as the interest of the subject, will command for his work and his arguments attentive consideration and a wide range of readers.

11. *Revue de Géologie pour les Années* 1869 *et* 1870, par M. DELESSE, Ingénieur en Chef des Mines, etc., and M. DE LAPPARENT, Ingeniéur des Mines. 188 pp. 8vo. Paris, 1873. (F. Savy).—This volume is the ninth in the series of valuable annual reports on the progress of geology by Delesse and Lapparent. Abstracts are given of papers in all departments of geology, both theoretical and applied, excepting that of paleontology.

12. *On the Siliceous deposit of the Upper Geyser Basin of Firehole River;* by F. M. ENDLICH. Sixth Annual Report Hayden's U. S. Geol. Survey.—An analysis of a variety, of milk-white color, cryptocrystalline structure, semi-vitreous aspect, and G.=2·4903, afforded Dr. Peale—

Si	Al	Fe	Mg	Ca, Na, Li	ign.
95·84	tr.	2·68	tr.	tr.	1·50=100·02

Another kind, of a light greenish-brown to greenish-white color, amorphous structure, vitreous luster and G.=2·0816, contained

6·3 of water. The mineral, a variety of opal, was collected by Dr. A. C. Peale, and is called by Mr. Endlich *pealite.*

13. *Mineralogia della Toscana;* Studii di ANTONIO D'ACHIARDI, Ajuto al Prof. Min. e Geol. nell Univ. di Pisa.—The second volume (404 pages, 8vo) of this very thorough work on Tuscan mineralogy and crystallography has been issued.

14. *Aragotite, Metacinnabarite.*—F. E. DURAND, in the Proceedings of the California Academy of Sciences, iv, 218, has given the name Aragotite to a bright yellow substance, impregnating a crystalline siliceous dolomite, and occurring with cinnabar. It volatilizes easily, after becoming dark red, but is not acted on by strong acids, or by oil of turpentine, alcohol or ether. It is supposed by the describer to be a volatile hydro-carbon related to idrialine.

Mr. Durand, on p. 219, figures two crystals of metacinnabarite, and states that the form is probably orthorhombic. The figures represent a rectangular prism with replaced angles.

III. ZOOLOGY AND BOTANY.

1. *The Megalops stage of Ocypoda;* by S. I. SMITH.—The *Monolepis inermis*, long ago described by Say,* and partially figured by Dana,† is undoubtedly a stage in the development of *Ocypoda arenaria.* The large size and peculiar structure of this megalops render it one of the most interesting forms of the group of larvæ to which it belongs. It is closely allied to the *Monolepis orientalis* Dana, from the Sooloo Sea, figured in detail on plate 31 of the Crustacea of the Wilkes' Exploring Expedition. The carapax is very convex above and narrowed toward the front. The front is deflexed and the extremity tricuspidate, the median tooth being long and narrowly triangular, while the lateral teeth are small and obtuse. The sides are high and impressed so as to receive the three anterior pairs of ambulatory legs. The third pair of ambulatory legs are closely appressed along the upper edge of the carapax, and extend forward over the eyes, the dactyli being curved down over the eyes and along each side of the front. The posterior legs are small and weak, and each is folded up and lies in a groove on the latero-posterior surface of the carapax. The external maxillipeds have almost exactly the same structure as in the adult *Ocypoda*, and, as in the adult *Ocypoda*, there is a tuft of peculiar hairs between the bases of the second and third ambulatory legs. This megalops is common upon the coast of the Southern States, it has been found at Block Island, and I have myself collected it, late in August, at Fire Island Beach, Long Island. In the largest specimen from the last locality the carapax is $9{\cdot}4^{mm}$ long and 5·6 broad.

A large number of young specimens of the *Ocypoda*, collected at Fire Island Beach, indicate plainly that they had only recently

* Journal Acad. Nat. Sci. Philadelphia, vol. i, p. 157, 1817.
† Crustacea Wilkes' Expl. Exped., plate 31, fig. 6.

changed from this megalops. Some of the smallest of these specimens, in which the carapax is 5·6 to 6·0^{mm} long and 6·1 to 6·5 broad, differ from the adult so much that they might very easily be mistaken for a different species. The carapax is very slightly broader than long and very convex above. The front is broad, not narrowed between the bases of the ocular peduncles, and triangular at the extremity. The margin of the orbit is not transverse but inclines obliquely backward. The ambulatory legs are nearly naked, and those of the posterior pair are proportionally much smaller than in the adult.

The adult *Ocypoda* is terrestrial in its habits, living in deep holes above high water mark on sandy beaches; but the young in the zoëa state are undoubtedly deposited in the water, where they lead a free-swimming existence like true pelagic animals, until they become full grown in the megalops state. Say mentions that his specimens were found cast upon the beach by the refluent tide and "appeared desirous to protect themselves, by burrowing in the sand, in order to wait the return of the tide," but they were more likely awaiting the final change to the terrestrial state. The tufts of peculiar hairs between the bases of the second and third ambulatory legs, and in the adult connected with the respiration, are present in the full grown megalops, and are undoubtedly provided to fit the animal for its terrestrial existence as soon as it is thrown upon the shore. The young in the megalops stage occur on the shore of Long Island, in August, and perhaps earlier. At Fire Island Beach, in 1870, no specimens of *Ocypoda* were discovered till the last of August, and those first found were the smallest ones obtained; by the middle of September, however, they were common on the outer beach, and many of them were twice as large as those first obtained. Although careful search was made along the beach for several miles, not a specimen of the adult or half-grown crab could be found. Every individual there had evidently landed and developed during the season. Probably all those living the year before had perished during the winter, and it is possible that this species never survives long enough to attain its full growth so far north.

New Haven, June 1, 1873.

2. *Corals and Coral Islands, by J. D. Dana. Reply to the criticism of P. Martin Duncan.**—In a criticism of Prof. Dana's work on Corals and Coral Islands, printed in a recent number of "Nature," (vol. vii, p. 119), Mr. Duncan saw fit to mention my name and certain of my views, adopted by Dana, in a somewhat discourteous manner. I therefore offer the following reply to some of his strictures, which are both erroneous and unjust.

Concerning the general character and plan of Dana's book it is not my intention to say anything, for these are matters which chiefly concern the author and publisher. It is to be presumed that they know, quite as well as any critic, the kind of book de-

* This "reply" was published in nearly the same form in "Nature," vol. vii, p. 423, but the present article was in type before the publication of the former.

manded by the public—at least by the American public—and experience every day shows the errors of critics in this respect. Certainly few authors have had more extensive and successful experience in writing strictly scientific books for the public than Professor Dana.

Mr. Duncan criticises the introduction of brief notices and descriptions of "animals which are not corals, and which in no way affect or produce coral reefs or islands," evidently alluding to the Actiniæ, Hydroids and Bryozoa; for he says, "all the notices and descriptions of the Actiniæ and Hydroidea might have been omitted, as they only confuse the subject." Surely Mr. Duncan ought to know, and if he does, should not ignore the fact, that *Millepora* and allied genera are true Hydroids, and at the same time form large and abundant corals, which contribute very largely to the formation of coral reefs, both in the Atlantic and Pacific Oceans. Moreover, this important fact is clearly stated by Professor Dana, on page 104, and its discovery is correctly attributed to Agassiz, and the animals are illustrated by a cut copied from his figures. It should be added that a confirmation of this discovery, made twenty-five years ago, has recently been published by Pourtales, (Deep Sea Corals, p. 56). That many of the ancient fossil corals were of the same nature scarcely admits of doubt, though I have elsewhere shown that this was not the case with all the so-called "Tabulata." Why, then, should this important class of corals be omitted from such a work? As for the Actiniæ, their relationship to the ordinary stony corals is so close, and their anatomy so nearly identical, that any general work upon recent corals would be very defective without some description of them. Moreover, they are the only near relatives of the corals that the majority of the readers of the book will ever be able to see alive.

The Bryozoa are also quite entitled to the page and a half allowed them in this work, for that they *do* contribute something to the existing reefs, can be easily demonstrated. A single species, (*Escharella variabilis*), abundant on the southern coast of New England, accumulates in vast quantities over extensive districts—enough even to form beds of limestone under favorable circumstances. It forms solid coral-like masses, two or three inches in diameter. Some coral-reef species grow even larger. And in Palæozoic times, the Bryozoa were relatively of still greater importance, some of the so-called "true-corals," evidently belonging to this group, in addition to those generally referred to it. The stony Algæ, also, are not to be ignored in treating of coral-reefs, and the half page devoted to them, might well have been extended, rather than omitted. Darwin, Agassiz, Major Hunt and others, besides Dana, have recognized their agency in affording calcereous matter to the reef limestones. Fine specimens of such limestones, composed almost entirely of their remains, may be seen in many American museums.

Mr. Duncan, in criticising Dana for adopting the classification that he prefers, makes this remark: "The introduction of Ameri-

can novelties to the exclusion of well-recognized European classifications is neither right nor scientifically correct." Are we to understand from this that "American novelties" are less valuable than French or English ones, providing they be equally true to nature? Or, that an erroneous European classification is more valuable than an American one that is correct? Certainly no one has contributed more, in the way of original investigations and discoveries, to a true classification of the corals, than Professor Dana, in his great work on the Zoöphytes of the U. S. Exploring Expedition, which was far in advance of any work on this subject that had been written in Europe up to that time (1846), and in some respects, his classification was far more natural than that proposed afterwards by Edwards and Haime.

Unfortunately, at that period the corals and polyps in European museums had not been described or figured by European writers in a manner accurate enough to make their identification possible, or even, in many cases, to show their generic and family relations. That Edwards and Haime, having access to those collections, and, having the benefit of Dana's great work, should have been able to make corrections and improvements was natural. Nor was it less natural, that, after the publication of the more accurate descriptions by Edwards and Haime, an American, with these and all other works at hand, and the freest possible access to the original types of Dana, the unrivaled collections brought together by Agassiz, and all the other collections (by no means few or small) in the United States, should, after twelve years devoted largely to the study of these corals, be able to make a few corrections and improvements, even in opposition to the views of certain European writers. But several European authors have also made numerous changes in the system of Edwards and Haime, and are likely to make many more. Certainly the time has not yet come when we can consider the classification of corals permanently fixed, any more than that of other classes of animals. Whether the "novelties" to which he refers be "scientifically correct," is quite another question, and one that must be settled in the scientific way, by the evidence of facts observed, not by denunciations, nor by dogmatic assertions. In my opinion, Mr. Duncan is very unfortunate in selecting the examples, which he gives, of the supposed inaccuracy of my views, as adopted by Dana. He cites the "Oculina tribe," which the writer has proposed to extend so as to include certain families referred by Edwards and Haime to the Astræa tribe, or suborder, and says, "the admission of Orbicella, which is really the old Astræa of Lamarck [a mistake,—not of 1801], and of Caryophyllia, into this well differentiated tribe, is simply absurd, for they possess structural characters sufficiently diverse to place them in different families." As a matter of fact, the writer, in several papers, has placed these same corals in different *families*, but has united these families, together with the Oculinidæ, Stylasteridæ, Stylophoridæ, Pocilliporidæ, etc., into *one* higher group, (suborder), called Oculinacea, and this is the view that Dana

adopts, so that the argument quoted is of no value, and becomes "simply absurd." Again, he says that "*Astrangia* was well differentiated long before Prof. Verrill was heard of," and states that Conrad, Lonsdale, and the distinguished French zoöphytologists, "consolidated the genus, which has nothing in common with the Oculinidæ." What he means by "consolidated," in this connection, it is difficult to understand, for all that Conrad and Lonsdale did, was to describe, very poorly, as species of "Astræa," a few fossil species, which were afterwards referred, doubtfully, to Astrangia by Edwards and Haime. The genus itself was first pointed out by Dana himself, in 1846, and named Pleiadia, (as stated in his book, p. 68), but it was not strictly defined at that time, as there were no species belonging to it in the collection of the Exploring Expedition, so that the name given by Edwards and Haime, two years later, has been universally adopted. But what my own age or reputation in the year 1848 has to do with it, is not obvious. That I have since carefully studied sixteen species of this genus, and described a considerable number of new ones, while but three were known to Edwards and Haime, is true; and that I have shown that the genus is closely related to Cladocora and Oculina, is equally true; and I presume that had Mr. Duncan enjoyed as good opportunities as I have had for studying this and all the related genera, he would long ago have arrived at the same conclusions, unless blinded by prejudices. It is certain that the soft parts of Astrangia, Cladocora, Oculina, and Orbicella are almost identical in all essential points of structure and form. Moreover, there are species of *Astrangia* that bud laterally, and finally grow up into branched forms not unlike Oculina; while the species of *Oculina*, when young, are encrusting, and bud like the ordinary Astrangiæ, some of them always remaining nearly in this condition; and as for the internal structure, there are Oculinæ in which the cells are but slightly filled up below, while there are Astrangiæ in which this also takes place to a certain extent. Nor does the existence of the cœnenchyma in the former afford more reliable characters for their differentiation; for it often occurs in Astrangia, having even the superficial radiating lines so characteristic of Oculina, and it is often nearly wanting in the latter. In fact, it is in some cases, quite difficult to say to which genus some specimens of certain species belong (*A. Haimei* V. and *A. Danæ* Ag., for example). Such are the genera that have "nothing in common," according to our critic. If any one should doubt the close resemblance of the soft parts, he can easily satisfy himself by studying the published figures of these genera; but the living animals resemble each other even more than do the figures. It would, in fact, be very difficult to write a diagnosis of the Oculinidæ which would include all the species, and at the same time exclude certain well-characterized Astrangiæ. These animals should then be compared with those of *Astræa*, (*Favia*), or any other true Astræans, when the contrast will be sufficiently

apparent. The relations between Caryophyllia and Astrangia, through Paracyathus, Phyllangia, etc., are sufficiently obvious; but as I have elsewhere fully discussed all these relations (Trans. Conn. Acad., I, pp. 512 to 540, 1869), it is unnecessary to say more at this time upon these points.

What Mr. Duncan means by saying that "*Caryophyllia Smithii*" was first discovered in the European seas by the Porcupine expedition is unintelligible, if by the name he intends the well-known species which has for many years passed under that name in England, and which Dana illustrates by a figure copied from Gosse's Actinologia Britanica, (the only figure, by the way, which Mr. Duncan specially criticises). The remark that *C. cyathus* is widely distributed in the Atlantic, extending "even as far north as the British Isles," was probably based on the discovery of the well-known *C. clavus* in the Straits of Florida, by Pourtales, coupled with the assertion of Mr. Duncan, in a former paper, that the latter and *C. cyathus*, and all other European forms, are only "varieties" of "*C. borealis.*" So Mr. Duncan's remark that "had Dana waited a little longer he would have had the opportunity of quoting correctly," was, to say the least, quite uncalled for, and unbecoming to him, since the alleged error originated with Mr. Duncan himself.

But the peculiar injustice of the critic is, perhaps, best seen in his failure to give Dana credit for his extensive original investigations upon the structure of coral reefs and islands, and his intimation that the facts and theories are mostly borrowed. He says, "the chapters on the structure of coral reefs and islands add little to the knowledge which Darwin, and Jukes, and Hochstetter have given us; but Dana's great powers of illustration enable him to reproduce the details with which we are so familiar, thanks to these authors, in very engaging forms." Professor Dana has given Darwin full credit and well merited praise, both in the preface and in many places in the body of the book, for his observations of facts and his discovery of the true mode of formation of coral reefs; but he also states the well-known fact, that his own observations had been made and his report written in 1842, before Mr. Darwin's report was published. The report of Mr. Jukes was published still later (1847); Dana's observations were, therefore, wholly original, and the chapters upon this subject are, as they purport to be, mainly a reprint of his original report, with such additions from other and later sources as seemed necessary or useful, all of which are credited to the various authors who have written upon this subject. In the preface the author says, "The observations forming the basis of the work were made in the course of the Wilkes Exploring Expedition around the world, during the four years from 1838 to 1842," and had Mr. Duncan taken the trouble to examine the original report, he would have found there the true source of most of the facts narrated.

The figures of corals are also mostly copied from those in the atlas of Dana's Zoöphytes, which were originally drawn from

nature by Dana himself, so that it is not strange that "some of them are very correct representations of nature." When the figures are not original, the source is invariably given. The charge that Dana does not give credit to others, is simply ridiculous, and in no case more so than when he is accused of treating the works of Edwards and Haime with "supreme contempt, inasmuch as he rarely gives them credit for their good work," for in the list (p. 379), of the species of corals described in his great work on Zoöphytes, prepared by the writer at his request, he has adopted, without hesitation, all the numerous rectifications made by them, as well as those made by the writer and others. A considerable number of rectifications also appear in this list for the first time, and it must therefore be quoted as the original authority for such changes. Nothing less than the complete absence of personal pride and vanity, and entire devotion to scientific truth, for which Professor Dana is so justly distinguished, could have induced him to have published such a list in this book. No doubt instances in which he has overlooked writings of more or less importance may occur, and the authorities for well-known facts may not always be given, for such references would uselessly encumber the book. In other cases, when to refer to another would be only to condemn, such references have been intentionally omitted, since they would serve no useful purpose. Such was the case, also when, in describing the extensive coral reefs of Brazil, so well explored by Prof. Hartt, and which have been shown by the writer* to consist of corals similar to, and partly identical with, those of the West Indies, he does not refer to Mr. Duncan's assertion (Quart. Jour. Geol. Soc., xxiv, p. 30), that "The Orinoco drains a vast tertiary region, and shuts in the coral-life of the Carribbean on the south;" or that "the Florida reefs consist of few species," when at least 45 had even then been recorded from them (others have since been added), which was a greater number than Mr. Duncan, in another place, admits from any existing reefs. Other statements and theories in the same paper, concerning the fossil and recent corals of the West Indies, have become, in consequence of the later discoveries of Pourtales, equally absurd, and needed no exposure. His assertion that the Isthmus of Panama was deeply submerged in the Miocene, reiterated in his criticism of Dana, may rest on no better foundation than the other assertions quoted from the same paper, notwithstanding the careless way in which he misquotes as to place of publication,† and misrepresents as to the contents, a brief article upon the same subject by the writer, who still looks in vain for such evidence as would be afforded by elevated coral

* Transactions of the Connecticut Academy, vol. i, p. 351, 1868; and this Journal, vol. xlv, p. 415, 1868.

† Mr. Duncan referred to my paper as published in the Proceedings of the Essex Institute, but it was published in the Proceedings of the Boston Society of Natural History, vol. x, p. 323.—A. E. V.

reefs related to those of the West Indies, but situated upon the Pacific side of the Isthmus, or upon its highest parts, or even by fossiliferous beds containing other fossils, thus situated. The well known existence of elevated coral reefs in the East Indies and Polynesia, and in the West Indies, proves nothing of the sort, for what little relationship exists between the corals of those regions can be explained in other ways. We think it singular that while certain geologists find it necessary to force the Gulf Stream across the Isthmus during the warm Miocene period, others find it quite as important to have it turned out of the Atlantic across the Isthmus during the Glacial period. Both assumptions seem equally gratuitous. A. E. VERRILL.

3. *Principles of Animal Mechanics;* by the Rev. SAMUEL HAUGHTON, F.R.S., Fellow of Trinity Coll. Dublin. 8vo. London, 1873. (Longmans, Green & Co.)—This volume is the result of observations and calculations made by the author during the last two years. The scope of the work is seen by a statement of a portion of the subjects treated, viz: the nature of muscular contraction; statical work done by muscles; dynamical work done by muscles; the absolute force of muscles; mechanical work done by the human heart; classification of muscles and their mode of action; theory of the hip and shoulder joints: principle of least action applied to the arrangement of the muscular fibers of the heart, etc.

The author has throughout reduced his elaborate observations made in the dissecting room to numbers, and then has availed himself of the principles of geometry and mechanics in their further discussion. Especially in his treatment of muscular curved surfaces, both ellipsoidal and skew surfaces, has the author made full use of the mathematics.

As a result of many calculations for the hip, shoulder, and other joints of many animals, Dr. Haughton states that he has "never met with any exception to the following propositions, which may be regarded as summing up my results:"—

1. Each muscle is constructed in relation to its joint in such a manner as to perform one kind of work only: and it performs that work to maximum advantage.

2. The number of muscles employed is determined by the number of distinct actions required from the limb.

3. The shape and form of the bones employed are the necessary consequence of the shape and power of the muscles in action.

4. The smallest muscle in the combination is as carefully adapted to its conditions of maximum work as the largest muscle.

From these propositions, supposed to be extended to the action of every muscle and joint, it appears to me to follow as necessary consequences:—

1. That a foreseeing Mind planned the type of the limb, and of its actions.

2. The idea of the limb and of its necessary actions being given; the number, shape, and arrangement of the necessary muscles

can be calculated and predicted with as much certainty as an astronomer can predict an eclipse.

3. That the shape and arrangement of the bones follow, of necessity, from the necessary arrangement of the muscles.

4. That any alterations, however slight, in any part of the combination of bones, muscles, and joints, would entail a loss of work, and lead to a less perfect mechanism.

5. Hence, the permanence and stability of each species (so far as relates to bones, muscles, and joints) is absolutely secured on the principles so admirably laid down by Mr. Darwin.

5. The profound study of the mechanism of joints lends no support to the postulate, that the similarities found to exist in the bones, muscles, and joints of animals may be explained by common descent fron a supposed common ancestor.

With respect to muscular action Dr. Haughton lays down these three laws:

Law I.—In comparing together different muscles, the work done in contracting is proportional to the weight of each.

Law II.—In comparing the same muscle (or group of muscles) with itself, when contracting under different external conditions, the work done is always constant in a single contraction.

Law III.—When the same muscle (or group of muscles) is kept in constant action until fatigue sets in, the total work done multiplied by the rate of work is constant. H. A. N.

4. *Check-list of the Ferns of North America north of Mexico.* Prepared and published by JOHN ROBINSON, Salem, Mass. April, 1873.—This check-list is published in two forms, 1st, on a thin sheet of folio-post for use in marking desiderata, etc., and 2d, in an ordinary 8vo pamphlet, this edition having some English names, and as it is printed on alternate pages, the names may be cut out and used as labels. The same numbers are used which appeared in Mann's Catalogue, the additional species being marked by letters added to the nearest number. The whole number of distinct species recognized is 126, besides which there are given 12 named varieties. Since the list was printed an additional species has been reported, viz: *Aspidium unitum* Mettenius, found near Enterprise, Florida, by Mr. C. E. Faxon of Cambridge, Mass. Doubtless there are yet undiscovered West Indian ferns in Florida, Mexican ferns in Arizona, and possibly undescribed species in California and along the Cordilleras. D. C. E.

5. *Flora Brasiliensis* of von MARTIUS, continued by Prof. EICHLER.—Fascicle 60, published in December, 1862, is a small one, containing three limited families, which are neatly elaborated by Dr. Engler of Munich; viz: *Olacineæ*, with 8 plates, one of them illustrating the new genus *Tetrastylidium; Icacineæ*, regarded as a distinct order, 4 plates (one of *Kummeria* of Martius, which is *Discophora* of Miers); and *Zygophylleæ*, with a single plate of *Kallstrœmia maxima*, which is a reproduction of that of *Ehrenbergia tribuloides* of Martius and Zuccarini's Nova Genera.

Fascicle 61, issued February, 1873, is much more ample. It

takes in only two tribes (*Phyllantheæ* and *Crotoneæ*) of the vast order *Euphorbiaceæ*, by Dr. J. Müller, who most creditably elaborated this family (*Euphorbia* excepted), in the Prodromus. We have here 42 plates and letter-press up to p. 292; so that the order will fill a volume, the second part of which, it is said, will appear before the close of the current year. The Brazilian species of *Phyllanthus* amount to 71, of *Croton* to 275. A. G.

6. *A Monograph of Ebenaceæ*, by W. P. Hiern, M. A. (Trans. Cambridge Phil. Society, vol. xii, part 1.) Cambridge, Eng., 1873, 4to.—The letter-press fills 300 pages; the illustrations are 11 lithographic plates; and there is a lithographed "plan exhibiting the affinities of *Ebenaceæ*." Mr. Hiern is very favorably known by two or three botanical papers, one of them on the *Batrachium* group of *Ranunculus*. He comes now to take a position among the few British botanists of the day who will undertake to elaborate an exotic order; and he has chosen one which has much needed a monographer. In the notice of the collections consulted, the herbarium of "*Lehmann*," now belonging to Cambridge University, is mentioned. That of the late *Dr. Charles Lemann* (to whose memory Bentham dedicated the genus *Carlemannia*) is doubtless the one intended.

In a brief account of the economical products of the order, 18 species of *Diospyros*, 2 of *Maba*, and one of *Euclea* are said to supply ebony; not to speak of other hard woods, such as boxwood and pear tree, which are artificially dyed black and used in commerce as ebony, nor of the ebony of the ancients, which according to Bertoloni, was furnished by a *Leguminosa*. Fourteen species of Diospyros yield edible fruits. Much the best, no doubt, is that of the Japanese *D. Kaki*—perhaps because it has been immemorially cultivated; the next may be our N. American *persimmon*, which is said to be better fit to eat after it has suffered frost. It is hardly edible without it. Characters are assigned for distinguishing *D. Virginiana* from the Asiatic *D. Lotus;* but it is added that some specimens, of which the native country is unknown, are extremely difficult to assign with certainty. For his very full list of the numbered collections, with names assigned to the numbers, our author has earned hearty thanks. Only five genera are admitted; and one of these is a new one, of a single species, from Madagascar, *Tetraclis*, well marked by the valvate æstivation of the corolla. Not only are lists given of the species of each geographical region, but a complete chronological enumeration of all the published species. The treatment of the systematic part of the monograph, the Latin diagnoses and the English descriptions, and the displayed synonomy, &c., seems wholly creditable; but there is a surplus of punctuation in the diagnoses, each adjective being isolated by a comma. The fossil species are all described in an appendix, but the author disclaims responsibility for them. A. G.

7. *Dodecatheon Meadia* germinates after the fashion of *Delphinium nudicaule*, &c., according to Naudin (Jour. Soc. Hort.,

France, 1872, p. 153), i. e., has petioled and connate cotyledons, from the base of which false radicle the succeeding leaves come forth. A. G.

8. *E. Regel: Animadversiones de Plantis vivis nonnullis Hort. Bot. Imp. Petropolitani.*—An undated pamphlet, issued this spring. It contains several Californian plants raised from seeds collected by Rœzl,—all but one of which we can identify. Regel's *Aster scorzonerifolius* is *A.* (*Xylorhiza*) *Andersonii* Gray. His *Callirrhoe spicata* (figured in his Garten-Flora, 1872, t. 737), is *Sidalcea malvæflora* Gray. His *Campanula Rœzli* is *C. prenanthoides* Durand and *C. filiflora* Kellogg. *Pentstemon Rœzli* remains unrecognized; but, except that the cells of the anther are said to be distinct, it might well be a form of *P. azureus* Benth. A. G.

IV. Astronomy.

1. *Astronomical and Meteorological Observations made during the year* 1870 *at the U. S. Naval Observatory;* Rear Admiral B. F. Sands, Sup't.—This thick volume gives the results of the routine work of the Naval Observatory for the year 1870, and is followed by four appendices. Three of these have been before noticed (vol. v, 320). The first appendix gives the result of the determination of the longitude of St. Louis, from observations made by Prof. Harkness of the Observatory and Prof. Einsbeck of the Coast Survey.

The final result is that the observing station at St. Louis, in the Washington University grounds, on St. Charles street, between 17th and 18th streets, is west of the center of the dome of the United States Naval Observatory at Washington by $0^h\ 52^m\ 36^s{\cdot}90 \pm 0^s{\cdot}026$.

2. *Aurora Australis.*—The Aurora was visible at Melbourne, S. Australia, on the evening of the 8th of July, 1872. It was first seen at $6^h\ 50^m$, and at $6^h\ 55^m$; there were for a short time shifting streams. It brightened again at $10^h\ 55^m$, reaching an altitude of 25°; and again at 11° 30′. It was seen also at Cape Otway. Coincident with the Aurora there were magnetic disturbances; the minimum easterly declination occurred at $8^h\ 45^m$, the maximum at $9^h\ 20^m$. On Nov. 25 traces were seen at $11^h\ 30^m$; the same again on December 9th.—*Monthly Rec. Melbourne Observatory.*

V. Miscellaneous Scientific Intelligence.

1. *Earthquake wave of August* 14, 1868, *and depth of the Pacific.*—J. E. Hilgard, of the Coast Survey, has calculated the depths indicated by the observations on the rate of transmission of the earthquake wave of Aug. 13, the shocks of which were nearly vertical at Arica, Peru. The first shock began at $5^h\ 05^m$ and lasted till $5^h\ 15^m$, and the first wave at $5^h\ 32^m$. We cite from an abstract of his paper in the Coast Survey Report for 1869, recently issued (p. 233), the table containing his results.

	Dist'nce from Arica.	Local time, first wave.	Long. from Arica.	Arica time, first wave.	Time of trans-mission.	Nautic. miles pr. hour.	Mean depth of ocean.
	Miles.	*d. h. m.*	*h. m.*	*d. h. m.*	*h. m.*		*Feet.*
Arica	------	13 5 32	------	----------	------	------	--------
San Diego	4,030	13 14 00	2 27	13 16 27	10 55	369	12,100
Fort Point	4,480	13 15 00	3 28	13 18 28	12 56	348	10,800
Astoria	5,000	13 20 50	3 33	13 24 23	18 51	265	6,200
Kodiak	6,200	13 22 00	5 32	13 27 32	22 00	282	7,000
Rapa	4,057	13 11 30	4 56	13 16 26	10 54	372	12,200
Chatham Island	5,520	14 13 30	7 03	13 20 33	15 01	368	12,100
Hawaii	5,460	13 14 00	5 42	13 19 42	14 10	385	13,200
Honolulu	5,580	13 12 00	5 50	13 17 50	12 18	454	18,500
Samoan Islands	5,760	14 14 30	6 40	13 21 10	15 38	368	12,100
Lyttleton	6,120	14 16 45	7 48	14 00 33	19 01	322	9,200
Newcastle	7,380	14 18 30	9 12	14 03 42	22 10	332	9,800
Sydney	7,440	13 20 00	9 13	14 05 13	23 41	314	8,800

Mr. Hilgard states that the superior depth of the Pacific in its eastern equatorial part, which there was otherwise good ground for believing in, is here made manifest, and that the depth in the northern part also seems to be small.

2. *The Challenger Expedition.*—Crossing the ocean to the West Indies, the expedition made several deep soundings. March 4th, in 21° 38′ N., 44° 39′ W., 1,900 fathoms; the bottom gray ooze and the bottom temperature 1·9° C. A crustacean related to the Astaci (and named by Dr. Suhm *Deidamia leptodactyla*, was brought up, which had no eyestalks or eyes. March 6th, 2,325 fathoms, bottom temperature 1·7° C.; brought up a little red mud, containing a single valve of a lamellibranch, and some sharks' teeth of two genera, with nodules that appeared to be coral altered to manganese ore: position 19° 57′ N., 53° 26′ W., 558 miles from Sombrero. March 10th, 2,675 fathoms, bottom temperature 1·6° C.; brought up some red clay with very little calcareous matter. March 11th, the line run out "over 4,000 fathoms or nearly five miles"; brought up the same red mud, containing some long cases of a tube-making Annelid (related to the shallow-water Clymenidæ and closely allied to Owenia), made out of the gritty matter, which occurs sparingly in the clay, and very few foraminifera; the depth was 2,975 fathoms, "a depth which does not appear to be greatly exceeded in any part of the ocean." March 13th, lat. 18° 54′ N., long. 61° 28′ W.; March 14th, still 35 m. from land, sounded in 1,420 fathoms; brought up material consisting chiefly of foraminifera, with spicules of sponges.

"The expedition sailed thence to Bermuda and Halifax, arriving at the latter place May 9th."—*Nature*, May 15.

3. *Michigan University.*—Prof. E. W. Hilgard, for many years connected with the University at Oxford, Mississippi, has recently entered upon the duties of Professor of Geology in the Michigan University. The change takes him to a new field, where he will be able to connect his very valuable work in the Gulf region with observations over that of the Great Lakes and the northern United States.

4. *British Association.*—The next meeting of the British Association will be held at Bradford, England, commencing on the 17th of September, and be under the Presidency of the distinguished physicist, James P. Joule.

5. *Report of the Superintendent* (Prof. BENJAMIN PEIRCE) *of the U. S. Coast Survey, showing the progress of the Survey during the year* 1869. 260 pp. 4to, with 28 maps. Washington, 1872.—Besides the Report of the Superintendent on the movements, researches and results of the Coast Survey, this volume contains several valuable papers in an Appendix: among them Prof. Agassiz, on the coral reef regions and deep sea-bottoms of Florida and the adjoining region; on observations by Coast Survey officers, on the eclipse of the sun of Aug. 7th, 1869; on the reclamation of tide lands, and its relation to navigation, by Assist. Henry Mitchell; on the earthquake wave of Aug. 14, 1868, by J. E. Hilgard.

6. *Year-book of Nature and Popular Science for* 1872; edited by JOHN C. DRAPER, Prof. Nat. Hist. and Physiology in the College of the City of New York, and of Chem. in the Univ. Med. College. 334 pp. 12mo. New York, 1873. (Scribner, Armstrong & Co.)—So small a work can of course contain only brief excerpts from some of the scientific articles of the year. This volume, besides its many short paragraphs of this kind, has scraps of information and opinions on a large variety of subjects, many of them not 1872 in origin, or of any particular year.

7. *Annual Record of Science and Industry for* 1872, by SPENCER F. BAIRD. 652 pp. 12mo. New York, 1873. (Harper & Brother.)—The readers of Harper's periodical publications and others will gladly welcome a volume containing the various scientific notices contributed to them by Prof. Baird. The Record embraces a large amount of information with regard to discoveries during the year in the various branches of science; the movements and explorations of expeditions; and the developments in many branches of industrial science. Besides the names of the several physical and natural sciences, it has the heads of Agriculture, Pisciculture and the Fisheries, Domestic and Household Economy, Mechanics and Engineering, Hygiene and Sanitary Science.

The book opens with an introductory chapter having the title "General Summary of Scientific and Industrial Progress during the year 1872," the most of which was evidently prepared for Prof. Baird by other hands. In general the chapter appears to be satisfactory. But in the geological part the writer cites very one-sidedly from the papers of 1872 (and 1871), putting among established truths the view that the Green Mountain rocks are Huronian; and that the metamorphism of Paleozoic and Mesozoic rocks is no longer to be believed in—making the old idea "an hypothesis based on very slender grounds." A little deeper look into the articles of 1872 would have brought to light evidence that the formations to which the great limestones (marbles) of the Green Mountains belong, and which all Canadian geologists have pronounced Paleozoic, include gneisses, mica-shists, chloritic mica

slates, garnet rock, and other metamorphic rocks which are as completely metamorphic as any of pre-Paleozoic time;* and that some of the kinds so closely resemble rocks of the Green Mountain series, that if lithological evidence is worth any thing, Mount Mansfield, the highest peak in these mountains, in Northern Vermont, is of the same age with some of the *Paleozoic* summits of Berkshire. An actual comparison of rocks has proved that the lithological evidence for the Huronian age of the Green Mountains will not hold, and that the denial of the existence of Paleozoic gneisses and mica slates connot be sustained by an appeal to Green Mountain facts.

8. *Reptiles and Birds:* a popular account of their various orders, with a description of the habits and economy of the most interesting. From the French of Louis Figuier. New edition, revised by Parker Gilmore ("ubique"). 624 pp. 12mo, with 307 illustrations. New York, 1873. (D. Appleton & Co.)—Figuier's popular works in science are well known. The figures are very good.

9. *Views of Nature, and of the Elements, Force and Phenomena of Nature and of Mind;* by EZRA C. SEAMEN. 140 pp. 12mo. New York, 1873. (Scribner, Armstrong & Co.)—This little volume contains many sound ideas. But the author is not sufficiently versed in science to criticize its principles, or to produce arguments on scientific points that have much weight.

10. *A Manual of Photography founded on Hardwick's Photographic Chemistry;* by GEO. DAWSON, M.A., Ph.D., of King's College, London. 8th edition. 276 pp. 12mo. Philadelphia: 1873. (Lindsay & Blakiston).—Hardwick's Photographic Chemistry has long been a standard work with photographers. Mr. Dawson has condensed it by wisely omitting much irrelevant matter—as the compend of elementary chemistry — theoretical speculations on light, &c.—thus making his manual more convenient than the original. The historical sketch very naturally omits all allusion to the contributions of American photographers to the art. But this does not much impair its value. The book is an eminently practical and useful treatise, not too learned for the unscientific reader, and exact enough for all useful purposes in the practice of this important art. B. S.

OBITUARY.

CHRISTOPHER HANSTEEN, for many years Professor of Astronomy and applied Mathematics at the University of Christiania, Norway, and Director of the Observatory there, died on the 15th of April last, at the age of 88. He made many valuable contributions to our knowledge of terrestrial magnetism, and was sent by his Government on an expedition into Siberia, with that object, in the year 1828. To him we principally owe the establishment of 11·1 years as the length of the periodicity of the magnetic declination, a period which also agrees with that of the maximum and minimum frequency of the solar spots, and which appears to be connected with that of many other terrestrial phenomena.—*Athenæum*, May 24th.

* This Journal, III, iv, 362, 450.